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TECHNICAL NOTE

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Techniques For Conducting Stream Habitat Survey on National Resource Land

by

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INTRODUCTION

The basic procedures contained in this technical note were previously developed for use in stream habitat surveys by the U.S. Forest Service (USFS). The procedures outlined herein contain these existing Forest Service methodologies as developed by USFS personnel in Regions 1, 4, and 3 along with modifications and revisions added by the authors to enhance the methodology for use on national resource lands. Credit for the majority of the basic methodology is extended to USFS fishery personnel in Regions 1 and 4. Assistance in revision and enhancement of these methods was begun by the authors when they both were employed by the USFS in Region 1 and has continued with assistance from various Forest staffs on National Forests in Montana, Idaho, Utah, and Washington. These procedures are still undergoing modification and change at present with the aid of BLM personnel in Utah and Wyoming as well as interagency coordinated efforts with USFS and USFWS personnel.

This technical note provides guidance and standards for conducting certain types of aquatic habitat surveys on national resource lands administered by the Bureau of Land Management. The objectives are to provide adequate procedures designed to evaluate most of the common environmental conditions that limit aquatic habitat and fish production and to assure that the aquatic habitat resource, including water quality, is given adequate consideration in the management of resources on national resource lands.

The surveys are designed to provide the necessary data to prepare basic management documents such as: the Unit Resource Analysis (URA), Management Framework Plan (MFP), Habitat Management Plan (HMP), Environmental Impact Statement (EIS), and other management planning documents. These surveys may show the need for, as well as means of, providing:

A. Cooperation with other agencies concerned with management of fish and their habitat.

B. Coordination of fish habitat resources with other resource and land use activities.

C. Direct habitat improvement projects.

D. Administrative or research studies.

E. Special habitat management plans.

F. Additional habitat surveys for more refined data or trend studies.

Habitat surveys are generally divided into four specific types, consisting of surveys for either cold or warm water fish species, or either running or standing aquatic habitat types. Within each of these, the field work may be segregated into three additional subdivisions consisting of:

A. Physical Habitat Surveys. Inventories and analyses of the physical characteristics of stream channels and lake basins and their immediate surroundings.

B. Water Quality Habitat Surveys. Inventories and analyses of the chemical, bacteriological and radiological constituents of water that affect aquatic flora and fauna.

C. Biological Habitat Surveys. Inventories and analyses of the aquatic flora and fauna, including fish.

The following procedures are largely concerned with the inventory of the physical characteristics of small streams and rivers. They also provide for habitat assessment as related to the various warm or cold water fish species. These procedures can also be used with modification to obtain minimum flow and discharge data in streams and rivers.

The authors hope that through continued field use, this methodology can be enhanced and used with satisfaction to meet the needs of the BLM field worker and administrators.

LEVELS OF SURVEY

Three levels of habitat sampling intensity are to be used, depending upon planning priorities and objectives, as follows:

A. Level 3 - Minimum Survey. Objective is to identify stream system and gather known data from State, Federal, or other records. This should be done in the office by district or area personnel before actual field survey begins. This is a minimum requirement for URA and MFP planning. No form is specifically designed for the level 3 survey but many of the items can be listed on Stream Habitat Survey Field Forms 6671-1 and 6671-2 (Appendix - Exhibit 1 & 2). Items to be accomplished in this survey are:

1. Location - State, County, District, Resource Area, Planning Unit, Drainage.

2. Survey unit drainage size (acres).

3. Stream length - miles on national resource lands, private, other public, and State.

a. Measurement and identification on a map (USGS or planimetric) each milepost at 1 mile intervals from mouth to headwaters.

4. Access - miles of stream near improved road, low standard road, road-trail, or remote (trail only).

5. Multiple use zone(s), land type, and vegetative type.

6. Principal use of drainage past and present history.

7. Land and water development plans - immediate, 5 years, long term.

8. Past survey data from the State Game and Fish Department or U.S. Forest Service, U.S. Fish and Wildlife Service, or U.S. National Park Service, if available, specifying when, by whom, where records are kept, and including, if known:

a. Threatened and endangered fish and wildlife and their status.

b. Type of fisheries native trout, anadromous, warm water catchable trout, non-game, or fishery.

c. Fish stocking history.

d. State water quality class.

e. State fishing water class.

f. State stream catalog No.

g. U.S. Geological Survey surface water and water quality records.

h. Ocular survey procedure for representative stream stretches (not all of the stream need be observed).

B. Level 2 - Extensive Field Survey. Obtains extensive field data concerning fish habitat and species for URA, MFP, and HMP planning. (This is the maximum survey effort for URA and MFP planning and a minimum effort for HMP planning. This survey is conducted under the direction of the State Office or District fisheries biologist. Interagency participation should be sought. This survey level includes:

1. Completed level 3 survey.

2. Use of ocular stream survey procedure outlined in Part II of this technical note.

3. Use of transect survey procedure outlined in Part I of this technical note, with the following exceptions:

a. Permanent marking of field stations is optional.

b. Transect locations need not be marked permanently; however, they may be described well for future reference.

c. Transects will not be read if only the ocular procedure is employed.

d. Size and kind of camera optional for all levels.

4. A quantitative and qualitative sampling of the fisheries will be accomplished if necessary. This is accomplished by a cooperative effort with the State Wildlife Agency through electrofishing or other approved methods.

5. Additional measurements to be included in surveys are:

a. Stream gradient profile - location of fish blocks, culverts, bridges, diversions, beaver activity, mining activity, pollution sources, stream improvement structures, intermittent sections, soil type and geologic landform, channel changes (man and nature).

b. Culvert locations on those tributaries contributing to the fishery.

c. Sinuosity ratio (ratio of the meander to straight stream sections).

d. Hydrochemistry, including turbidities and suspended sediment, and bacteriological analysis.

e. Streambank and channel stability classification (Exhibit 3 - USFS methods).

f. Hydrologic effects of vegetation manipulation.

g. Evaluation of optimum habit values for aquatic habitat based on the data collected employing the transect survey procedure.

C. Level 1 - Intensive Field Survey. Obtain intensive field data concerning physical, chemical, and biological characteristics of a stream for use in project or activity planning. This survey is conducted under the direction of the State Office fisheries biologist. State Wildlife Agency and interagency participation should be sought. Items included at this level are:

1. Completed Level 2 and 3 survey.

2. Completion of ocular stream survey procedure outlined in Part II of this technical note.

3. Completion of transect survey procedure outlined in Part I of this technical note, with modifications:

a. More than five transects per station may be required on streams less than 15 miles long to assure statistical reliability at the 80 percent confidence level.

b. Data collected for this statistical reliability include pool quality, bank stability, bank cover, pool-riffle ratio, bottom materials (desirable, undesirable, and spawning sizes).

c. Stations and transects will be permanently marked for trend data.

d. Management plans and objectives will dictate time interval to resurvey for trend data.

4. Other measurements to be included, if necessary, are:

a. Streambank and channel stability ratings.

b. Stream gradient profile.

c. Sag-tape measurements.

d. Chains for bedload movement.

e. Intragravel environment measurements.

f. Hydrochemical and temperature measurements.

g. Fish species, benthic fauna, and flora measurements for species composition and diversity indices.

TRAINING

Before being able to satisfactorily complete transect and/or ocular survey, the surveyor must be thoroughly trained in the transect and ocular survey methods. The trainee must be shown how to classify pools, classify bottom materials, classify spawning sites, and estimate percentages of pools, bottom materials, bank stability and other parameters listed for a Level II transect survey. It takes approximately 10 field days in two stages to train a person to a satisfactory level for completing the transect and ocular surveys. After 8 days of training, the trainee can effectively complete stream surveys. The traineee then works again with the experienced surveyor for 2 days to correct any problems or misunderstandings.

SAFETY

Survey work should always be conducted by 2-man crews when safety is a factor. To prevent falling, nonslip materials, such as nylon or felt, should be attached to soles of boots. When surveying deep streams, life vests should be worn. State and Federal boating laws should be observed when employing boats for survey work.

PART I

Transect Survey Procedure

This section suggests guidance and standards for conducting aquatic habitat surveys through employment of the transect procedure. This survey procedure is designed to provide extensive or intensive aquatic habitat inventory data.

The transect survey should include the ocular method, described in Part II, as specified under the Levels of Survey.

Office Procedure

A considerable part of the survey procedure involves office preparation. Most office preparation applies to Parts I and II of this note; differences will be referenced in the appropriate sections under Part II.

Survey Maps. A 1 inch or preferably a 2 inch scale planning unit planimetric base map or a USGS topographical map is required as part of the permanent survey records. This map will show sample station locations and other pertinent information.

Delineation of Survey Units. All BLM streams are to be completely surveyed. Once a named stream is classified, it will be subdivided into individual survey units; e.g., West Fork, East Fork, etc. Stream names must show on the base map. An example of stream survey unit designations is shown in Illustration 1.

Plotting Station Locations. Stations are merely beginning points and transects are located from these points. See level of survey for permanency requirement of station or transect.

A. Stations should be located on the field maps (2 inch scale) using proportional dividers. In the event 2 inch scale maps are not available, 1 inch scale maps may be used. Station number 1 is located at the downstream point with other station numbers progressing upstream as shown in Illustration 2. When the first station is located, allowances should be made to locate the first transect a sufficient distance upstream to avoid instream structures or stream channel modification, such as bridges, culverts, widestream widths, or other features which may occur preventing satisfactory transect location. An exception to this location rule could be in desert areas where streams may become dewatered or intermittent as they approach the valley bottom or sinkhole. In this case, station number one could be located at the headwaters source. Subsequent station number then would progress downstream at the designated intervals until the dewatered section or sinkhole is reached, as shown in Illustration 4.

1. If a survey unit is interrupted by a reservoir, pond (except beaver ponds), or lake, the distance from the outlet to the inlet is excluded

from the length of the survey unit. However, this distance should be noted in the Remarks section of the survey form.

B. The actual interval between sampling points depends on total stream length. Stations will be located at 1 mile intervals for streams that are 15 to 30 miles in length. Closer spacing of stations may be necessary on shorter streams to obtain sufficient samples for maintaining acceptable limits of statistical reliability. When a stream length exceeds 30 miles, intervals longer than 1 mile may be used. If map differences on remote streams, without access, approach the dividing points for two different sampling frequencies, it is usually desirable to survey the unit at the greatest of the two sampling frequencies. Illustration 7 shows the suggested transect interval to be used on major rivers where river widths are extremely wide and the 100 foot transect interval would be unsatisfactory to assure adequate data collection. These transect frequency intervals are designed for extensive surveys. In most cases, the resulting data are sufficient to write general management plans for individual planning units. However, if more intensive management plans are desired for a particular survey unit or complex of survey units, the sampling frequency should be increased accordingly.

When a stream is in multi-status ownership, only those stations falling on national resource lands should be established, except in cases where prior landowner approval is obtained. However, investigators should observe the entire length of the stream to determine what conditions prevail on sections in private or state ownership, and whether or not these conditions will affect BLM stream habitat management programs.

Plotting Stations on Aerial Photographs. All base map station locations will be transferred to corresponding aerial photographs. Photographs are then used to make actual ground location of sampling stations. Once located, the photographs should be pinpricked and the number of the station written on the reverse side.

Aerial photographs shall be made a permanent part of the survey records and will be very useful in relocating stations for remeasurement. Cost of photographs should be considered as part of the project costs.

Coding Sample Stations. On names streams or survey units, stations are identified by using the prefix "S" followed by consecutive letters of the alphabet and numbers. Shorter unnamed tributaries are coded with a prefix "X" followed by consecutive letters of the alphabet and numbers.

Watershed Condition Report. Each survey unit shall be described by a short narrative report on Form 6671-5 - Stream Habitat Survey Summary and Analysis (Appendix Exhibit 5). The report should contain information on past, present, or future activities or happenings which have or could influence the present status of the habitat. Some suggested items to consider include:

A. Range conditions, use by classes of stock, type grazing systems, number of animals, and annual use in animal months.

B. Recreation uses may include various types of activities such as off road vehicle (ORV), etc. Recreation facilities should also be listed. Consider future developments.

C. Mining--describe past and/or present methods. Some mention should be made of number and types of claims that are not presently active.

D. Woodland sales in terms of acres of cutting, and estimated cut in next 5 years.

E. Water quality - Describe quality of water, existing pollution problems, and any long or short term threats that could degrade water quality conditions.

F. Road construction data should include miles of road constructed by types with drainage or without drainage, and miles to be constructed in the next 5-year period.

G. Special land use permits which have or may have an effect on aquatic habitat, such as dams, diversions, etc.

H. Wildlife uses, i.e., heavily used game range with unstable soils; nongame uses, etc.

I. Soils classes in the drainage, and erosion potential.

J. Fire history for class c, d, and e fires.

K. Flood history, i.e., effects of past floods on the watershed.

Survey Equipment. The field equipment listed below should be obtained for use in survey work.

A. Camera -- 35 mm; instamatic or other; color film, Kodacolor-X recommended; wide angle lens optional.

B. Light meter.

C. Polarized filter--optional.

D. Camera tripod--optional.

E. Iron stakes, 18" to 24" angle iron, optional.

F. Aluminum tags, 4" x 4", optional.

G. Tape - 100 feet, nylon, waterproof-graduated in tenths of a foot.

H. Carpenter's rule - metal, optional.

I. Stopwatch or watch with second hand.

J. Abney level or clinometer.

K. Thermometer, range 0-220° F. or 0-50° C.

L. Hip boots or chest waders with nylon or felt soles.

M. Tatum holder, 8-1/2" x 11-1/2".

N. Pocket steroscope--optional.

O. Velocity headrod--or current meter (Gurley or Price)--optional.

P. Spray paint--optional.

Q. Hatchet.

R. Nails.

S. Magic markers.

T. Hach water analysis test kit (Model Al-36-B, or Model DL-ER).

U. Water sample bottle, 250 ml. plastic--optional.

V. Water sample bottle, 100 ml. glass, sterile with styrofoam ice pack cooler--optional.

W. Form 6671-1 (Transect Field Form).

X. Form 6671-4 (Transect Photo Identification).

Y. Lightweight back pack for carrying equipment-optional.

State and Federal boating laws should be observed when employing boats for survey work.

Field Procedure

Field habitat surveys shall be conducted during low water periods when there is no snow cover or ice cover. It is during these periods that pool and water quality, very important habitat factors, are most critical. Low water periods are also correlated with clear water periods which facilitates conditions for the collection of the most advantageous stream channel measurements and provides the most safe working conditions.

Locating Sample Stations and Transects. Sample stations are located in the field by use of base maps and aerial photographs. Field locations are based on the predetermined location of milepost spots and changes in geomorphic and hydrologic conditions along the stream. Sample stations can be marked on the ground for reference. Stations can be marked by either a 4" x 4" aluminum tag, metal tag, or rock cairn or other suitable marker, and a note made on form stating type of marker used. Once the sample station is located, the field man will measure 100 feet upstream to locate the first transect (to avoid bias). Distance is measured with an engineer's tape along either bank, following the curves or meander lines of the channel. Distance may also be measured up the middle of the stream when desirable. The route selected for measuring distances between transects should be the same for all transects to assist in relocation of transect stakes at a later date. Right and left banks are determined by facing downstream. A note should be made on Form 6671-1 - Stream Habitat Survey Form, describing the route selected for measuring distances between transects, i.e., left bank, right bank, or middle of stream. Where roads parallel streams for some distance, vehicle odometer readings can be used to reference the location.

If transects are to be referenced, one metal stake can be driven into the ground above the high water line at each transect location. Stakes may be located on either bank. Stake locations should be selected at open bank areas to aid in future recognition. Rock cairns constructed around the stake and painted will also aid in recognition. A note should be made on Form 6671-1 as to where individual transect stakes are located (e.g. left or right bank).

The transect line is located by stretching an engineer's tape from the metal stake across the stream at a right angle to the flow or channel alignment (see Illustration 6).

Although optional, a rock cairn on the opposite bank may be valuable for relocation of the transect line, particularly when transect lines are located on curved sections of channel.

Another aid for future relocation of transect sites is the use of location or bearing tags. Aluminum tags, approximately 4" x 4" square, are nailed to nearby trees facing the transect stake. Sample station and transect numbers should be inscribed on the tag. Approximate distances or compass bearings from the tag to the stake may be helpful to relocate stations. Tags are recommended for all stations and transects where possible. Similar tags with station and transect numbers located on trees adjacent to trails and roads are also useful in relocation work. Records should be kept to note which transects are marked with bearing tags, as well as the size and species of trees on which the tags are nailed.

Habitat surveys conducted on streams located in primitive and/or wild and scenic river study areas require special attention. Transect location markers should be limited to small, unpainted metal stakes and rock cairns. No paint, aluminum tags, or plastic flagging shall be used. Stakes and rock cairns should not be located on or immediately adjacent to well-traveled trails.

Locating Camera Points. Camera points are used to obtain photographic evidence of the prevailing habitat conditions. Specifically, photographs are taken to record the type of bottom materials, streambank stability, discharge levels, and bank vegetation occurring at a particular transect.

Photographs thus provide a valuable basis for future comparisons and trend changes.

To be most effective, camera points should be reserved for transects which fall across slow or smooth-moving water such as pools. These locations provide the best opportunity for recording types, as well as changes in types of bottom materials. As a minimum requirement, one camera point should be established for each 10 transects or 2 stations, or whenever land types or channel geomorphology deviates significantly.

Camera points may be located over the transect stake or at any point along the transect line, possibly on the opposite bank. If a camera point is located along the line, a notation should be made on Form 6670-1, as to distance from the transect stake.

The 35 mm camera should be used for taking aquatic habitat transect photographs. Although optional, a polarized filter is highly desirable to reduce surface water glare and give better definition to stream bottom materials. Kodacolor-X color negative film should be used. The following photographs are required for each selected camera point:

A. Cross-channel Photograph. This photograph is taken to record the types of bottom materials occurring along the transect line. The camera is tipped down and pointed along the transect line. The transect tape should bisect the photograph. On very wide channels, concentrate by focusing on the nearest part of channel. As a rule of thumb, the camera should be focused at a point located 1/3 the distance across the stream. Form 6671-4 - Stream Habitat Transect Photo Identification (Appendix Exhibit 4) should be included in the photo at that point to identify the transect.

A polarizing filter should be used, following the manufacturer's instructions for these photographs. When adverse lighting conditions occur, it is recommended that three shots be taken as follows:

1. Take light-meter reading.

2. Select F-stop for any shutter speed between 125 to 250 of a second.

3. Take first photograph.

4. Take second photograph at one F-stop below that selected for first photographs, but at same shutter speed.

5. Take third photograph at one F-stop above that selected for first photograph, but at same shutter speed.

This method will generally insure the photographer of at least one acceptable picture.

B. <u>Up and Downstream Photographs</u>. Photographs are taken for general views of the stream both above and below the station or transect line to record the type of vegetative cover and stability of the streambanks. Only one picture need be taken for each of these views. Use the same shutter speed as selected for cross-channel photographs. Form 6671-4 should be included in the photo between 15 to 20 feet from the camera.

To prepare Form 6671-4 (see Appendix - Exhibit 3) for photograph identifications, fill in required information with a black, broad-tipped, felt-type marker. When possible, the form should be held by hand to receive maximum illumination and reduce shadows. To identify up and downstream views, the upper left and lower right-hand corners of the form have been blackened. When taking upstream views, fold the lower right-hand corner under. Reverse the procedure to identify downstream views.

In addition to transect pictures, field workers are urged to photograph various items of interest, such as unstable banks, overgrazed bank cover conditions, waterfalls, mining activity, pollution, etc., with the 35 mm camera, using color film. Color slides taken with 35 mm cameras are also desirable for these items, but color prints should be made from the slides for the file folders.

<u>Measurement of Habitat Factors</u>. The stream's cross-section measurements will be made along a line projected at right angles to the streambank.

A. <u>Stream Width</u>. The total width of the stream channel will be measured to the nearest foot from bank to bank. The width of the watered stream channel will also be measured, including the distance beneath undercut banks.

If channel separations occur, width measurements are measured and recorded for each individual channel. A channel is considered separated if it is divided by the deposition of materials, such as sand or gravel. An individual rock or boulder does not constitute a channel separation. The distance across the channel separation (the dewatered area) will also be measured and recorded on the back of form.

Individual channel will be identified by adding a letter to the transect number. For example, if a channel separation occurs at the first transect, the individual channels are identified from left to right as T-1a and T-1b (see Illustration 5). Appendix Exhibit 1 shows proper way to record transect number on Form 6671-1. Form 6670-6 - Stream Habitat Surveys Reference Form (Appendix - Exhibit 6) is provided for quick field reference, and should be attached to recorder's tatum holder.

B. <u>Riffle Width</u>. The riffle width is the difference between the total stream water width and the pool widths. Thus, a stream which has 10 feet of pools and is 20 feet wide would have 10 feet of riffle.

C. <u>Average Depth</u>. Average depth is measured along the tape 1/4, 1/2, and 3/4 the distance across the stream with a carpenter's rule or velocity headrod. Depth is measured to the nearest tenth of a foot. The sum of these three measurements divided by four equals the average depth for individual transects. These measurements are divided by four since one measurement is considered as zero at the bank to provide for a more adequate average depth reading. If an individual measurement falls on top of a protruding rock or log, the measurement should be taken either up or downstream to approximate the average depth in that vicinity. However, when depths are measured across the transect to obtain a cross section bottom contour map, the measurement should be recorded as zero, or the actual depth, when it falls on top of a protruding rock or log.

D. Pools. Pools are usually defined as the deeper, placid, and slower-moving sections of a stream which fish utilize for rest and shelter. In contrast, riffles are the faster and more shallow waters in which fish forage and feed. Both types of water are important to the well-being of fish.

As a general rule of thumb, the optimum stream is equally divided (50-50 ratio) in surface area between pools and riffles. However, to be truly optimum, pools should meet certain standards necessary to support a productive aquatic habitat.

In addition to pool and riffles, some investigators refer to a "glide" or a "run" which is a section of stream where the water surface isn't broken, but is shallow and has a fast velocity. It is intermediate between a pool and a riffle. The tail-end of long pools may be shallow and form a "glide" or a "run." These can be considered pools but classification is left up to the discretion of the surveyor.

1. Pool class rating. Each pool will be rated as a class 1, 2, 3, 4, or 5 pool on physical features and the rating recorded in pool class column. In general, pool size (in relation to the average size of the stream in the vicinity of the sample) is the critical factor. Depth and fish shelter are qualifying factors. The following discussion of the three major pool types (1, 3, and 5) should provide a basic concept of pool differences. The accompanying Pool Class Rating Guide, Illustration 8, identifies more specific field conditions into pool ratings.

Examples of certain classes of pools are:

a. No. 1 pool. A pool whose greatest length or width is much greater (about 2 x or more) than the stream's average width within the vicinity of the sample. This pool is at least 2 feet deep and has abundant fish shelter, such as logs, roots, boulders, vegetation, or overhanging banks. If it is exposed, it must be over 3 feet deep.

b. No. 3 pool. A pool whose length or width is equal to and less than 2 x the stream's average width within the vicinity of the sample. This pool is intermediate in depth and shelter to either a number 1 or a number 5 pool.

c. <u>No. 5 pool</u>. A pool whose length or width is much less than the stream's average width within the sample area. This pool is shallow and exposed.

Pools also may be rated 2 or 4 when intermediate conditions are noted. An example of a No. 2 pool would be one whose length or width within the sample area is 2 x greater than the average stream width, but is more shallow or has less shelter than a No. 1 pool. Similarly, a No. 4 pool could be one whose length or width was equal to the stream's average width but is relatively more shallow and exposed than a No. 3 pool.

A quantitative method to classify pools is based on the following numerical ratings for the various pool parameters - size, depth, and cover:

(1) Size. Rate 3 - if pool is much longer or wider than average width of stream within 50 feet above and below the transect. Rate 1 - if pool is much shorter or narrower than average width of stream within 50 feet above and below transect.

(2) Depth. Rate 3 - if deepest part of pool is greater than 3 feet. Rate 2 - if deepest part of pool is between 2 and 3 feet deep. Rate 1 - if deepest part of pool is less than 2 feet. Note: Reference to the deepest part of pool refers to any part of the total pool, not just that portion under transect line.

(3) Pool Cover. Rate 3 - if pool has abundant cover. Rate 2 - if pool has partial cover. Rate 1 - if pool is exposed. Note: Pool cover refers to hiding places for fish such as undercut banks, overhanging brush and trees or their root systems, logs, boulders, aquatic plants, shade, choppy water surface, or water depth exceeding 3 feet.

A final classification or pool class is based on the total number of quality points for all three quality factors as follows:

Total Rating	Pool Class
8-9 points	1
7 points	2
5-6 points	3
4-5 points	4
3 points	5

Note: The total of 5 points for a class 3 pool must contain 2 points for depth and 2 points for pool cover.

2. Pool Frequency and Width. Pool frequency is determined from width measurements of pools bisected by a transect line. The width of each pool bisected by the transect is entered on a separate line on Form 6671-1. More than one pool may be found along the cross section line. The width of each pool will be measured to the nearest foot and recorded.

3. Pool Location. The location of the pool is recorded as being associated with either the right bank (R), the left bank (L), or the center (C) of the stream if not bank associated.

4. Pool Feature. Significant features associated with the pool are recorded. There may be features such as boulders (B), overhanging bank (OB), water undercut bank (UC/B) depth (D), or vegetation (V) if brush or tree roots form the major feature of the pool, etc. Beaver dams (BD) may also be the significant feature for the pool.

E. Stream Bottom Materials. The types of material found on stream bottoms are very important. Different sizes and kinds of materials affect the spawning and food production capabilities of a stream. In addition, large materials provide some protection as hiding places for fish.

Bottom materials are classified as follows:

1. Organic debris--undecomposed woody or herbaceous materials such as leaves, twigs, and logs.

2. Organic muck--a black ooze-like material associated with meadows. Muck is composed of decomposed organic materials.

3. Clay--compact and sticky material in bed form.

4. Silt--usually thin layer of grey-colored material found in standing water. It is composed of very fine organic materials, with lesser amounts of clay and sand particles. Silt becomes suspended when disturbed.

5. Sand--particles smaller than fine gravel.

6. Fine gravel--0.1 to 1.0 inches in diameter (Spawning gravels).

7. Coarse gravel--1.0 to 3.0 inches in diameter (spawning gravels).

8. Small rubble--3.0 to 6.0 inches in diameter.

9. Large rubble--6.0 to 12.0 inches in diameter.

10. Boulders--individual segments of rock larger than 12 inches in diameter.

11. Bedrock--large solid masses of rock without individual form.

Bottom materials are recorded by total feet of intercept of each type along the transect line. Investigators should examine the general aspect of all or any of the different bottom types. As an example, a 3 foot section under the transect is characterized by a sandy bottom with fine and coarse gravels uniformly interspersed. If, by looking at an area 1 foot wide and 3 feet long beneath the tape, the greatest surface area is seemingly composed of materials less than 0.1 inch, the investigator would record 3 feet of sand. However, should the fine gravels be so concentrated in 1 square foot of this area that the average size of materials approaches 1/2 inch, the recorder would show 1 foot of fine gravel and 2 feet of sand.

The investigator must record the materials on the stream bottom as they occur; that is, record the materials as observed. For example, silt is generally a very thin blanket of material overlying another material such as small rubble. Although the small rubble is obvious, silt should be recorded as the bottom material only if it is covering the bottom of the stream.

When water is murky or muddy, investigators must feel the bottom with their hands to determine bottom material types. Occasionally, samples of materials should be raised to the surface for size checks.

Of the 11 types of materials listed, seven are considered desirable based on aquatic insect productivity. They are organic debris, muck, silt, fine and coarse gravels, and both small and large rubble. Of these, silt and large rubble are considered the most productive. Sand and clay materials are the least productive of all bottom types.

Silt can be both beneficial and detrimental depending on circumstances. Silt containing large amounts of fine organic materials has been found to be a highly productive media for those insects consuming vegetative debris. However, silt produced in large and continuous quantities may smother fish eggs, plants, and aquatic insects. Under natural conditions silt is rarely a problem. Silt stemming from man's activities, such as overgrazing and mining, may be very detrimental if produced in large quantities over long periods of time, particularly when silting occurs during the low water periods.

In analyzing the value of bottom materials, the investigator must determine whether or not silt is beneficial or detrimental. Where silt deposition occurs only in still water and as a product of nature, it will be considered beneficial. If silt deposition is extensive in gravel or riffle areas and occurs as a result of man's activities, the materials will be considered detrimental.

F. Bank Cover. Bank cover is living streamside vegetation in close proximity to the stream. To be effective, for shade and water temperature control the vegetation must be twice as high as the distance to the water's edge. For example, a willow 16 feet tall must be within 8 feet or less of the water's edge to be effective as a streamside shade cover plant. Vegetative cover along streams provides shade for water temperature control, hiding cover for fish, bank stability through root systems, and a place for insects to live and breed which indirectly provides a source of fish food as these insects fall into the stream. For these reasons, generally the taller the vegetation, including grasses and forbs, the greater its value. Therefore, basic evaluation procedures are oriented toward the taller vegetation; that is, if trees or tall shrubs are present in any numbers, ratings are based on their occurrence rather than the undergrowth of shorter plants.

The class of streamside vegetation which influences the transect points will be recorded for both the right-hand and left-hand banks based on the vegetative characteristics extending 50 feet above and below the end of each transect. ("Right" and "left" banks are identified while facing downstream.) Four classes of streambank vegetation are recognized. Each vegetative type is given a numerical rating which will be used in the final analysis to determine overall condition of the stream. The numerical rating should be entered in that column on the field form. The vegetation classes and numerical ratings are:

1. Forested (4 points) - if streambank is medium to heavily covered, or shaded by growth of tall trees or dense riparian vegetation.

2. Brush (3 points) - if streambank is bordered or shaded by growth of tall brush or dense riparian vegetation. Thinly scattered tall trees may be present but are not the dominating feature. (Alders, hawthornes, willows, tall herbs and grasses could be present).

3. Grass (2 points) - if streambank is medium to heavily covered with tall grasses and forbs or low shrubs or a combination of these plants.

4. Exposed (1 point) - if streambank is covered with scattered low grasses, forbs, or shrubs, or banks are barren of vegetative cover (soil, rock, etc.) or a combination of these.

When recording bank cover ratings on Form 6671-1, investigators will not evaluate the banks of small channel separations, unless they extend the entire 50 foot distance above and below the transect line. Leave the appropriate square under "cover" blank when this situation occurs.

G. Bank Stability. Few streams exist which do not have some degree of streambank erosion. Stable banks are generally associated with those covered by dense vegetation, or those characterized by large or solid rock. Unstable banks are usually associated with sparse vegetative cover, overgrazed stream bottoms, stream channel alteration, etc. Banks in a vertical profile may be highly unstable when composed of fine materials and with very little vegetative root systems to bind the soils together. However, vertical and in some cases, undercut banks located in meadows are frequently very stable. Therefore, investigators must view streambank stability from the standpoint of whether they are eroding at a slow and normal rate, or whether erosion is accelerated and is contributing excessive amounts of sediments. Undercut or overhanging banks could be present as part of a totally stable bank system.

Investigators should not confuse stream bottoms with streambanks (see Illustration 6). Streambanks are generally defined as a small narrow strip along the edge of a stream formed by the abrupt angle from the stream bottom to the high water line.

Bank stability is evaluated by observing the right and left streambank, a distance of 50 feet above and below each end of each transect. Thus, as with bank cover, investigators will not evaluate banks along channel separations unless they extend a full 50 feet in each direction from the transect line. Each bank stability class, if assigned a numerical rating, should be entered on the field form for each bank.

The bank stability classes and their numerical ratings are:

1. <u>Bank totally stable (4 points)</u> - No evidence of bank erosion at any flow condition.

2. <u>Bank greater than 50% stable (3 points)</u> - Moderate to heavy erosion and bank sluffing taking place during high and low flow conditions or from land management practices. Conditions do not allow time for bank recovery to proceed to 50% stability.

4. <u>Bank totally unstable (1 point)</u> - Heavy erosion and bank sluffing conditions occurring over the majority of the streambank length. No evidence of bank recovery, erosion constant.

a. <u>Bank class</u> - The dominant composition of the immediate stream components shall be recorded along the streambank a distance of 50 feet above and below the end of each transect. Composition classes can be listed individually or occurring together, such as boulder, gravel bar, exposed soil, grass and rocks, grass and soil, soil and rocks, rooted soil (trees and brush), etc.

b. <u>Landform Gradient</u> - The gradient of the land adjacent to the streambank will be measured at each transect using either an abney level or a clinometer, for a distance of at least 100 feet inland, if possible, from each streambank's edge. This gradient profile will be useful in assessing land management practices proposed or operating adjacent to the streambank, and erosion potential. The actual measured gradient percent should be entered on Form 6671-1. The following are the landform slope gradient classes which will be useful in evaluating adjacent watershed conditions:

<u>Erosion Susceptibility Classes</u>

0 - 2.5% gradient	Stable
2.5 - 5.0% gradient	Stable to slight
5.0 - 10% gradient	Slight to moderate
10 - 20% gradient	Moderate to severe
20 - 30% gradient	Severe to critical
30% gradient	Critical

c. Riparian Zone Width - The riparian zone is that habitat which is closely related to the watercourse. It is important to maintaining the integrity of the stream system and provides transition habitat for many wildlife species as they acquire water or seek shelter. Generally, land disturbance in narrow riparian zones should be avoided to lessen introduction of sediment into watercourses.

The zone width may be entered in the appropriate space as so many "feet" or other defined unit.

H. Ungulate Damage. Most serious damages caused by ungulate use are sloughing of streambanks by trampling and the removal of streambank riparian vegetation by grazing. The most prevalent streambank damage by ungulates is caused by sloughing from trampling by domestic livestock grazing. Ungulate damage is evaluated by observing the right and left streambank, a distance of 50 feet above and below each end of each transect. Thus, as with bank cover and stability, investigators will not evaluate banks along channel separations unless they extend a full 50 feet in each direction from the transect line. Each ungulate damage class is assigned a numerical rating which should be entered on the field form for each bank. Do not assume that ungulate use means ungulate damage.

The ungulate damage classes and their numerical ratings are:

1. Bank stable and undamaged (4 points) - Partial or no evidence of bank damage; about 90-100% of bank area free from ungulate use. Little or no bank erosion or sloughing present.

2. Bank damage less than 50% (3 points) - Banks are 50 to 90% free from ungulate damage. Some erosion and sloughing evident but recovery present after season of use.

3. Bank damage greater than 50% (2 points) - Banks receive from 50 to 90% damage from ungulate use. Moderate to heavy bank erosion and sloughing occurring during season of use and continuing during nonuse period. Conditions do not allow for natural recovery of banks to 50% stability.

4. Bank damage excessive (1 point) - Banks receive 90-100% damage from ungulate use. Severe bank erosion and sloughing occurring over virtually entire streambank surveyed. No evidence of bank recovery, erosion constant.

a. Ungulate Class - The ungulate class shall be recorded in the remarks section of Form 6671-1 as to the species of ungulate using the area, i.e., livestock, sheep, horse, big game species, etc.

I. Aquatic Flora. Aquatic plants are beneficial to fishery habitat in many ways. These include:

1. Production of oxygen.

2. Living and hiding place for aquatic insects and fish.

3. Food source for herbivorous fish and insects.

The types of vegetation are also important. Therefore, aquatic vegetation will be classified as either rooted (R) or clinging (C). Rooted vegetation is generally found growing in bottom materials, such as muck, silt, and sand. Clinging plants such as the algaes and mosses are associated with rubble and boulder type materials. All vegetation measured must be 1 inch long or longer at the time of measurement.

Vegetation is measured to the nearest foot of intercept occurring beneath the transect line. Amounts of intercept are not accumulative; that is, a 4-inch patch cannot be added to another 5-inch patch at another point along the transect line and recorded as 1 foot of intercept. (See Appendix Exhibit 1 for examples of recording aquatic vegetation.)

J. Gradient. Stream gradient is important from the standpoint that the pool-riffle ratio is frequently and closely correlated with gradient. As a general rule, high gradient streams are characterized by more numerous smaller pools created by boulders and fewer high quality pools. Low gradient streams show a reverse trend. Gradient is also important for many other reasons, including a limiting factor for kinds or types of suitable stream improvement structures. Gradient is extremely important to land managers when considering resource activities that will alter or disturb streambanks that are highly susceptible to erosion.

Gradient is determined by using the percent scale on an abney level or clinometer. Gradient shots will be taken at the beginning and the end of each station, and should extend for at least 100 feet above and below the transect. The readings are added and averaged to the nearest .1 percent and recorded on Form 6671-1.

K. Velocity and Discharge. The importance of and reasons for measuring streamflow velocity are very similar to those given for stream gradient. In general, there is a direct correlation between gradient and velocity; that is, the steeper the gradient the greater the velocity. Streamflow velocity is measured in feet per second and recorded to the nearest tenth of a second. Measurement of velocity and discharge can be done in one of three ways:

1. The first method consists of floating a partially submerged object downstream for a distance of 100 feet, or fractions of this distance, such as 50 or 25 feet. The section selected for floating should be reasonably uniform in width, depth, and roughness from bottom materials. The floating time is determined for three individual trials and then averaged to the nearest tenth of a second. The distance the object is floated is then divided by the average time, and is recorded to the nearest tenth second.

The float should be released in the main current. If the float is caught by rocks or eddy current, the process should be repeated until the object has made a free float the entire distance. This method is the least accurate or desirable of the actual physical methods, but should be used if instruments are not available.

The estimated discharge in cubic feet per second can be calculated from the formula, $Q = \frac{l \times w \times d}{t\ (0.8 \text{ or } 0.9)}$ where, Q = discharge in cubic feet per second; l = length of measure section, in feet; w = average width of measured section, in feet; d = average depth of measured section, in feet; t = time in seconds that it takes for object to float the measured length of the section; 0.8 = correction factor for stream bottom with irregular rocky bottom; 0.9 = correction factor for stream bottom with sandy bottom.

2. The second method for determining stream velocity involves the use of a velocity headrod. Headrod velocities may be made at any one of the transects that have uniform flow and bottom conditions as stated above in "1." (See Appendix Exhibit 11 for explanation of field form.)

3. The third and most precise method involves the use of the current meter (Gurley, Price, Pygmy, etc.) for making precise discharge measurements across the transect line. Appendix Exhibit 12 shows a copy of the U.S. Geological Survey discharge measurement form which should be used in recording this data.

L. Temperature. Stream temperature is a vital and important component of habitat. Although temperature has a pronounced effect on the carrying capacity of dissolved oxygen in water, its relationship to production of flora and fauna is more important. To fully evaluate temperature would require continuous recording measurements. Continuous temperature recorders can be used in certain stream areas if it is appropriate. However, sporadic measurements are helpful and serve as general indicators of conditions during the more critical periods of low water.

Temperature is measured to the nearest degree Fahrenheit or Centigrade. After measuring air temperature, water temperature will be measured. Both temperatures should be taken in the shade. These data are recorded on Form 6671-1. The time of day that measurements are taken should be recorded.

M. Turbidity. Turbidity affects light penetration in water, which in turn has a pronounced effect on the growth of aquatic plants. Turbidity also affects many species of fish classed as sight feeders. In addition, suspended materials absorb solar heat, causing water temperatures to increase.

Streams will be classified as:

1. Clear - little or no suspended materials.

2. Milky - slight to medium turbidity.

3. Muddy - heavy turbidity.

Turbidity is recorded on Form 6671-1. Investigators will explain the reasons for milky or muddy conditions and determine the source of pollution when possible. Remarks should also include whether or not observed turbidities are temporary or permanent in nature.

N. Spawning Gravels. Estimating available spawning gravels is optional. Generally, investigators can make broad qualitative and quantitative estimates as they conduct the standard survey. However, when availability of spawning gravels involves certain species of fish, whose spawning requirements are quite restrictive, such as those for anadromous fish or species of rare and endangered fish, investigators should consider doing a more detailed survey. If detailed surveys are desirable, the State Division of Wildlife Resources should be consulted first for available survey information. Spawning gravel survey data should be located on the base map and correlated with sample station locations.

O. Access. The ability or inability of fishermen to reach a stream or portions of a stream has a pronounced effect on fishing pressure and harvest. Trails and roads close enough to be used by the average fisherman can be considered as access accommodations. Roads or trails in close proximity to the stream may affect water quality and fishing habitat. Stream access is measured in miles by types as follows:

1. Remote - no trails or roads.

2. Low-standard trails - game or nonmaintained trails.

3. Improved trails - maintained.

4. Low-standard roads - without drainage.

5. Improved roads - with drainage facilities.

Type of access is recorded to the nearest mile on Form 6671-1.

Collecting Related Habitat Information. There are numerous factors associated with streams which have an important and direct bearing on habitat quality. Many of these factors will occur at points located between sampling stations. Therefore, it is mandatory that field workers examine those portions of a stream between sampling stations. Investigators should keep complete notes on the reverse side of Form 6671-1. Many of these factors may be found in State or other Federal record files if stream surveys have been conducted in the past.

The following are factors which have influence on habitat quality.

A. Channel Obstructions. Channel obstructions are very important in relation to upstream fish migration. Several types of manmade barriers may occur such as dams for water storage or diversion, culverts, or velocity blocks created by constriction of the channel. Waterfalls, log jams, beaver dams, and steep gradient cataracts are examples of naturally occurring obstructions. Field workers should mark obstructions and locations on the base map and determine if the obstructions are total or partial barriers to upstream migration or movement. Observers should consider barriers in relation to high and low water flows. Record height of migration barrier next to symbol on field map if over 3 feet high; most trouts can jump a 3-foot barrier if an adequate jumping pool is available below the barrier. When possible, recommendations for removal or passage facilities should be included with an estimate of costs. Symbols to be used are illustrations on Exhibit 9, Appendix 9.

B. <u>Channel Debris</u>. Most natural channel debris, such as fallen trees, is highly desirable from the standpoint of providing cover for and for checking stream velocities. In many mountain streams, a substantial number of pools are created by fallen trees which deflect stream currents and cause scouring actions. Excessive debris which threaten to create fish migration blocks, or which may cause excessive bank or toe-of-slope cutting, should have their locations marked on the field map. Investigators should note locations of excessive debris areas, methods of removal, and cost estimates for removal projects. Symbols to be used are illustrated on Exhibit 9, Appendix 9.

C. <u>Pollution</u>. Many types of water pollution exist, including mining wastes, livestock wastes, garbage dumping and littering, oil spills, etc., which may affect national resource lands. Investigators should describe the type of pollution, its source, and give recommendations for abatement. Field workers should check State water quality standards to determine the present water quality class in areas where pollution problems occur. See Exhibit 9, Appendix 9 for coding of pollution.

D. <u>Channel Changes</u>. Man-caused channel changes or alterations generally cause adverse impacts on stream habitat by increasing sedimentation and increasing velocities. Field workers should record the mileage of channel affected to the nearest 100 feet. Total mileage of changes will be recorded without regard to age or stability appearances of the changes. However, workers should provide recommendations for stability control work as needed.

Common examples of man-caused channel changes include road construction encroachments, mining and dredging areas, and clearance areas for culverts and bridges. New channels constructed to reduce the number of bridges needed on new roads are examples of extreme channel alterations.

E. <u>Potential and Active Erosion Sources</u>. Sedimentation is extremely important as related to habitat quality. Field workers should remain alert to potential sources of sedimentation as well as active sources. Field notes should include descriptions of landslides, slump areas, erosion at culvert inlet and outlets, and high banks which are contributing or are potential contributors of sediments. Notes should include recommendations for protection or correction of serious erosion sources. Symbol to be used is illustrated on Exhibit 9, Appendix 9.

F. Loss of Streamflow. Many streams go underground during low water periods. Location and length of dry sections should be recorded. (See Exhibit 9, Appendix 9).

G. Beaver Information. Field notes should be kept concerning beaver activity. Locations and status of ponds (deserted or active) should be recorded on field map. Symbols to be used are illustrated on Exhibit 9, Appendix 9.

H. Fish Planting Access Sites. Many streams are dependent upon hatchery stocking. For proper stocking, distribution should be widespread. Field workers should observe and record approximate numbers of sites where planting trucks can reach the stream.

I. Angler Use. Each survey unit should be evaluated from the standpoint of fishing pressure. Therefore, angler use estimates can be described as light, medium, or heavy. This information can usually be obtained from District or State Division of Wildlife Resources personnel. Since angling use or pressure is a relative term, workers should reference the degree of use per year/per mile as follows:

1. Light use - less than 100 fisherman days.

2. Medium use - more than 100, but less than 1,000 fisherman days.

3. Heavy use - more than 1,000 fisherman days.

J. Fish. Field notes, concerning numbers, size (minimum - maximum), and species of fish observed in the stream should be recorded. If fish are observed during spawning periods, general locations and numbers should be noted.

K. Impoundment Sites. Proposed dam sites, including those proposed by other agencies for flood control, irrigation, hydroelectric production, fishing lake development, and storage for downstream fisheries release during low-flow periods, should be noted and shown on the base map. Data concerning the name of the sponsoring agency and proposed construction dates should also be recorded on reverse of Form 6671-1 or 6671-2.

L. Spring Sources. Artesian type springs are potential water sources for hatchery sites and rearing ponds and should be recorded. As a general rule, springs producing more than 100 gallons per minute should be noted, and the water temperature measured. Their location should be shown on the base map.

M. Fish Stocking. State and Federal fish stocking information pertaining to numbers, species, sizes, and frequency of planting should be recorded. These data should be recorded on Stream Habitat Survey Summary and Analysis, Form 6671-5.

N. Other Factors. Brief field notes should be recorded when factors, other than those listed, are encountered. General notes concerning abrupt gradient changes, striking variations in streamside vegetation, or possibly information concerning pool-riffle ratios not reflected by transect measurements should be recorded.

Recording Field Data. Form 6671-1 - Stream Habitat Survey Field Form is designed to record all information collected and measured at each individual sample station (see Appendix Exhibit 1). In situations involving numerous pools and channel separations, an additional form may be required to record all necessary data for each station. Available information on all items should be completed in the office prior to field work.

Following are instructions for completing all items on Form 6671-1:

Item 1: State - self-explanatory.

Item 2: County - self-explanatory.

Item 3: District - self-explanatory.

Item 4: Resource Area and planning unit - self-explanatory.

Item 5: Drainage - enter the name of the nearest downstream river. In the event item 5, survey unit, is a river itself, enter the name of the river it flows into.

Item 6: Stream Unit - enter the name of the stream surveyed. When the survey unit is an unnamed tributary, the parent stream should be noted in parenthesis. For example, SA (No. Fk. Sheep Creek), or SC (No. Fk. Sheep Creek).

Item 7: Location - enter legal description (T., R., Sec.) of stream at its station location.

Item 8: Survey Station - enter the station number.

Item 9: Investigators - self-explanatory.

Item 10: Date - self-explanatory.

Item 11: Transect Number - enter number of transect. When multiple channels occur on one transect, individual channels are identified by adding consecutive letters to the transect number. Individual channels should be identified from left to right banks. (See Illustration 5.)

Item 12: Total width of channel - enter width of each individual channel from bank to bank, to the nearest foot.

Item 13: Water width - enter width of each channel's watered section.

Item 14: Riffle width - enter difference between sum of all pool widths and total water width.

Item 15: Depth 1 - enter depth to nearest tenth of a foot at 1/4 distance from bank.

Item 16: Depth 2 - enter depth to nearest tenth of a foot at 1/2 distance from bank.

Item 17: Depth 3 - enter depth to nearest tenth of a foot at 3/4 distance from bank.

Item 18: Average depth - enter average depth to nearest tenth of a foot (sum of the three depth measurements divided by four).

Item 19: Pool width - enter width of individual pools to nearest foot. Only one pool width should be entered per horizontal line (see Appendix Exhibit 1).

Item 20: Pool Class - see item D1 under Measurement of Habitat Factors.

Item 21: Pool Location - see item D3 under Measurement of Habitat Factors.

Item 22: Feature - enter the most dominant physical feature of the pool, see item D4 under Measurement of Habitat Factors.

Item 23: Aquatic Plants - see item I under Measurement of Habitat Factors.

Items 24-34: Bottom Materials - see item E under Measurement of Habitat Factors.

Items 35 and 41: Bank Cover - see item F under Measurement of Habitat Factors.

Items 35 and 42: Bank Stability - see item G under Measurement of Habitat Factors.

Items 37 and 43: Class - enter dominant composition of each bank - see item G4a under Measurement of Habitat Factors.

Items 38 and 44: Landform Gradient - enter gradient of land at least 100 feet inland from bank.

Items 39 and 45: Ungulate Damage - see item H under Measurement of Habitat Factors.

Items 40 and 46: Riparian width - see item G under Measurement of Habitat Factors.

Item 47: Stream Gradient - enter stream gradient to nearest 0.1 percent.

Item 48: Velocity - enter stream velocity to nearest half-foot per second.

Item 49: Access - see item O under Measurement of Habitat Factors. Enter length of each type of access to the nearest mile.

Item 50: Water Temperature - enter temperature to nearest degree Fahrenheit or Centigrade.

Item 51: Air Temperature - enter temperature to the nearest degree Fahrenheit or Centigarde.

Item 52: Time - enter the time in military numbers (e.g. 0830, 1415, etc.) when temperature measurements are taken.

Item 53: Elevation - using the best available contour map, enter the best elevation estimate possible for each station.

Item 54: Turbidity - see item M under Measurement of Habitat Factors.

Item 55: Water analysis - check appropriate blank indicating which test analysis was done.

Item 56: Water quality class (State) - enter State water quality.

Item 57: Fishing water class - enter appropriate classification of fishing.

Item 58: Stream catalog number - enter appropriate catalog and section number of stream surveyed as taken from the State's Inventory and Classification Catalog Report.

Item 59: Multiple Use Zone - enter the multiple use zone for each station, i.e., people, travel, water, or other (describe).

Item 60: Land Type - enter geomorphic association of land type. (See Illustration 9 for land type legend.)

Item 61: Vegetative Type - enter dominant vegetative type, symbol and species. (See Illustration 10 and BLM MR 4412.11A.)

Item 62: Discharge (c.f.s.) - enter approximate streamflow at time of survey. Note whether it is estimated (est.) or measured (float - F, velocity headrod - VHR, or metered - M).

Item 63: Percent Stream Shaded - indicate the percent stream section is shaded during the day.

Item 64: General remarks - enter transect and camera point location notes. Enter information concerning item listed under Related Habitat Factors.

<u>Water Quality Habitat Survey</u>. Surveys of this nature include qualitative and quantitative measurements of both the physical and chemical properties of water. Complicated procedures and equipment are required to do a complete analyses of water quality as well as the services of trained biologists or technicians. However, there are certain qualitative measurements that can be measured with a minimum of training and equipment, and serve well as general indicators of habitat quality. Therefore, present survey procedures include a few mandatory and some optional measurements.

A. <u>Required Chemical Analyses</u>. Required measurements of water quality include:

1. Water temperature
2. Turbidity
3 pH
4. Dissolved oxygen
5. Carbon dioxide
6. Alkalinity (phenolphthalein and methyl orange)
7. Conductivity or total dissolved solids

Instructions for measuring temperature and turbidity are explained in <u>Measurement of Habitat Factor</u> section. Instructions for measuring the remaining values are generally attached to the equipment being used. A Hach test kit, model Al-36-B, should be available at each district office for analyses of these parameters.

B. <u>Optional Chemical Analyses</u>. There are many chemical elements and compounds which affect the productivity of a stream. When land managers contemplate large and expensive stream improvement projects to increase fish production, they should consider a thorough analysis of water quality. This is particularly true of streams which historically have been low producers of fish, or streams suspected of being polluted. Frequently, water quality is found to be a limiting factor of fish habitat.

When additional water quality data are deemed necessary on a temporary or permanent basis to monitor planned land activities, minimum analyses should include measurements of other elements and compounds such as nitrates-nitrites, phosphates, trace minerals and heavy metals, sulfates, sediments, detergents and others depending on the type of activity to be monitored. Water samples collected for these analyses should be done according to standard U.S. Geological Survey procedures.

For analysis of pollutants, such as pesticides, radioactive materials, and bacteria, field personnel should seek the aid of the appropriate State or Federal water quality laboratory.

Biological Surveys. Biological surveys include inventories of both aquatic flora and fauna. However, field personnel will generally confine their efforts to inventorying the flora and invertebrate populations. Fish population inventories may be done on a cooperative basis with the State Wildlife Agency when necessary.

A. Aquatic Invertebrates. The number, size, and species of aquatic invertebrates are important to fisheries habitat, as invertebrates are the primary food source for most salmonid and other fish species. Aquatic macroinvertebrates include insects such as mayflies, stoneflies, caddisflies, and diptera (two-winged flies); crustaceans such as crayfish and shrimp mollusks, such as snails and clams; and freshwater earthworms. Benthic surveys of macroinvertebrates can be of more value than chemical surveys due to the sensitivity of these organisms to long term pollution stresses.

B. Methods of Collection. General food grade indices and species diversity may be obtained by collecting aquatic organisms with specially designed equipment from specific sized areas, and from various locations within a stream channel. Workers may obtain these food grade indices by the following procedures:

1. Use a square foot bottom sampler and obtain four samples at each selected sampling station. Samples are taken from riffle and/or pool areas and are randomly selected across the transect area from bank to bank. If biological trend data are desired, then samples should be taken from uniform substrates to aid in future comparisons and statistical reliability.

2. Remove all organisms and debris from the sampler and place in container or bottles with preservative (alcohol 70% Isoprophl, 95% Ethanol, 10% formalin, etc.) and transport to laboratory for sorting, counting. After counting, dry organisms by blotting. Measure their volume by liquid displacement.

3. A more intensive analysis of macroinvertebrate samples should be done in a laboratory specifically set up for such analysis.

C. Biological Indices of Water Quality - Macroinvertebrate communities have been widely used as indicators of conditions in polluted streams. Benthic organisms can be of more value than chemistry of water as an indicator of stressed conditions because of the sensitivity of certain groups of organisms to environmental disturbance. The productivity (biomass) of a stream's habitat can be directly related to the number and type of organisms present and the degree of stress received. (See Appendix Exhibit 13.)

1. Measurement of Species Diversity - Analysis of the community structure of benthic macroinvertebrates require the collection of organisms, from each station desired to be sampled, be sorted and the number of species determined. Unless detailed studies of pollution stresses are desired, five benthic samples taken from uniform substrates for future trend comparisons should be adequate to assure species community structural relationships. Species diversities indices are represented as mathematical expressions which describe the community structure of the numbers and kinds of organisms present. These indices should be developed from the benthic samples to show species diversity or dominance in the various stream sections as the habitat conditions may be stressed by physical and/or organic pollutants.

2. Food Grade Analysis - The degree of richness of a stream's biomass can be related to species diversity as an indicator biological productivity of a water's substrate. Food grade determinations are optional and can be used for special situations such as studying the feasibility of stream improvement projects.

Following collection and sorting, benthic organisms can be measured volumetrically by liquid displacement. Food grades can be determined by comparing organism volumes with the following ratings:

a. Food Grade 1 (exceptionally rich) - volume greater than 2 cc. and numbers greater than 50 organisms per square foot.

b. Food Grade 2 (average richness) - volume from 1 to 2 cc. and numbers greater than 50 organisms per square foot.

c. Food Grade 3 (poor in food) - volume less than 1 cc. and numbers less than 50 organisms per square foot.

D. Fish Surveys. Fish surveys may be conducted to collect information concerning population numbers, production, age and growth, species composition, harvest, migration and movement, and many others. In stream habitat management work, land managers may make use of information concerning numbers, size, and species of fish as related to stream improvement projects and habitat management for threatened and endangered species. This type of information is useful in evaluating the effectiveness of different types of improvement work. The information can also be used to evaluate the impacts of land management activities on a fish population.

Fish surveys are considered a responsibility of the State Wildlife Agency and should be conducted with their assistance.

E. Aquatic Plants. The values of and reasons for measuring aquatic flora are explained in item I under Measurement of Habitat Factors.

Analysis of Data

Field data are divided into two categories and analyzed separately. The first category is termed PRIORITY "A" LIMITING FACTORS and include such factors of pool frequency, pool quality, stream bottom materials, bank cover and bank stability. The second category is termed PRIORITY "B" LIMITING FACTORS which includes all other habitat factors.

The division of habitat factors is an arbitrary separation based on the premise that "A" factors absolutely essential for maximum fish production are frequently lacking, but are more easily improved with stream improvement programs than are "B" factors. However, "B" factors are important and should be considered as complementary or supporting factors.

Computation of Priority "A" Limiting Factors.

A. Add all transect measurements for each survey unit, including those for unnamed tributaries 3 miles or longer which flow into the survey unit, to obtain:

1. Total of all stream water width measurements.

2. Total width of all pools.

3. Total width of all pools classed 1, 2, and 3.

4. Total width of stream bottom covered by organic debris, muck, silt, fine and coarse gravels, and small and large rubble.

5. Sum of all bank cover ratings.

6. Maximum possible sum of all bank cover ratings.

7. Sum of all bank stability ratings.

8. Maximum possible sum of all bank stability ratings.

B. Compute the following percentages to the nearest percent:

1. Percent of pool-riffle ratio optimum or (A).

Step 1. Total width of all pools divided by total of all stream water widths or $\frac{A2}{A1}$ = x (Percent of total stream width in pools).

Step 2. Use Illustration 10 to obtain the percent of pool riffle ratio optimum or (A).

2. Percent of pool quality optimum or (B).

Step 1. Total of all pools classed 1, 2, and 3 divided by the total width of all pools or $\frac{A3}{A2}$ = (X) (Percent of all pools rated 1, 2, and 3).

Step 2. Multiply percent of pool-riffle ratios as determined in B1 Step 2 above to the result obtained in B.a. Step 1 or (A) x (X) = (B).

3. Percent of stream bottom covered by desirable bottom materials, or (C). (C) = Total width of stream bottom covered by organic debris, muck, silt, fine and coarse gravels and small and large rubble divided by the total of all stream water width measurements or $\frac{A4}{A1}$ X 100%.

4. Percent of bank cover optimum or (D). (D) = sum of all bank cover ratings divided by the maximum possible sum of all bank cover ratings. $\frac{A5}{A6}$ X 100%.

5. Percent of bank stability optimum or (E). (E) = sum of all bank stability ratings divided by the maximum possible sum of all bank stability ratings. $\frac{A7}{A8}$ X 100%.

C. Compute the habitat condition as a "percent of optimum" from the average of the parameters computed in B above as follows:

1. $\frac{(A) + (B) + (C) + (D) + (E)}{5}$ = (F) or percent of habitat optimum.

Computation of Priority "B" Limiting Factors

A. Average depth (nearest tenth of a foot) - sum of all transect averages and divide by number of transects measured.

B. Average width of stream (nearest foot) - sum of all transect measurements and divide by number of transects measured. When multichannels are encountered, add individual channel measurements for each transect and treat as one total width measurement.

C. Percent stream shaded - average of all transect percent shade estimates.

D. Aquatic vegetation clinging (to nearest tenth percent) - sum footage of vegetation and divide by total of all stream width measurements.

E. Aquatic vegetation rooted (same as above).

F. Percent sedimentation - sum of all transect sand, clay, silt, and muck measurements divided by the total water width measurements.

G. Average stream gradient (to nearest tenth percent grade) - divide the total of the gradient measurements by the number of measurements.

H. Average water velocity (to nearest tenth foot per second) - sum all velocities measured and divide by number of measurements.

I. Average landform gradient - divide the total of the gradient measurements for right and left bank, each separately, by the number of each bank's measurement.

J. Stream discharge - enter average discharge from all station measurements.

K. Turbidity (general description).

L. Access (nearest half mile of each type).

M. Water Quality Analysis - check appropriate type of analysis conducted.

Recording Analysis Data. Form 6671-5, Stream Habitat Survey Summary and Analysis (Appendix - Exhibit 5), is designed to summarize general information and analyses data for each survey unit. Summation and analysis should not be done until the entire unit has been surveyed. The following are instructions for completing all items on this form:

Item 1: State - self-explanatory.

Item 2: District - self-explanatory.

Item 3: Area - self-explanatory.

Item 4: Drainage - enter same name as shown on field Form 6671-1 for the survey unit being summarized.

Item 5: Stream unit - enter name of unit on field Form 6671-1 being summarized.

Item 6: Location - enter legal description (township, range and section) of stream at its mouth or at Station 1.

Item 7: Investigators - enter names of field workers who did survey work. In parenthesis, enter name of person completing this form.

Item 8: Date - enter data of analysis - enter the basin and watershed code number appropriate for this survey unit as shown in supplement.

Item 9: Total length of stream - enter total length of stream in the drainage extending from the mouth to the source, to nearest 1/4 mile.

Item 10: Total length of stream surveyed - enter total length of stream surveyed extending from the mouth to the headwaters. Round mileage to nearest 1/2 mile. Record mileage for each individual landownership classification. Record percentage of stream ownership from mileage classification.

Item 11: Total number of sample stations - enter number of sample stations established by ownership classification. An example of a stream with the lower 1.2 miles in private and 3.4 miles in BLM ownerships would be recorded as: 2 stations on private and 3 stations on BLM lands. The totals in item 10 above would be recorded as 1 mile private and 3.5 miles BLM. The total in item 9 above would be recorded as: 4.6 miles plus mileage from the 4.6 mile point to the source.

Item 12: Total of all stream width measurements - enter sum of all measurements recorded on Form 6671-1, for the respective survey unit being analyzed.

Item 13: Total channel width - enter sum of all channel width measurements.

Item 14: Total width of all pools.

Item 15: Sum of total widths of all pools classed 1, 2, and 3.

Item 16: Sum of total footage of desirable bottom materials.

Item 17: Sum of total spawning gravels - fine and coarse gravels.

Item 18: Sum of all bank cover ratings.

Item 19: Sum of all bank stability ratings.

Item 20: Elevation - enter approximate elevations for the lowest and the highest part of the survey unit.

Item 21: Multiple use zones - self-explanatory.

Item 22: Number of camera points - enter total number of camera points established for this survey unit.

Item 23: Total costs - enter total cost of survey and individual items as shown, to nearest dollar.

Item 24: Cost per station - enter cost per station to nearest dollar by dividing total cost in item 21 by total number of stations shown in item 11.

Items 25-31: Priority "A" Limiting Factors - enter percentages as derived in computations.

Items 32-42: Priority "B" Limiting Factors - enter appropriate computational data as derived.

Item 43: General remarks - enter notes concerning items 1-14 as listed in Collecting Related Habitat Information. Use supplemental sheet if necessary.

Item 44: Watershed condition report - enter watershed condition information as explained in Collecting Related Habitat Information. Use supplemental sheet if necessary.

Item 45: Management recommendations - enter recommendations for multiple use coordination requirements and special management requirements, including improvements. In the event survey analyses indicate serious resource problems exist, consideration should be given to recommending a more intensive survey. Use supplemental sheet if necessary.

Reporting and Storing Data

Remeasurement of Habitat Surveys. A primary purpose of the habitat survey program is to provide the district manager with the basic data needed to prepare fisheries habitat management plans.

In addition to providing basic inventory and analysis management data, remeasurement may provide trend information depending on objectives and priorities and the level of survey sampling intensity. Therefore, all stream surveys will be remeasured as dictated by objectives and statistical reliability desired for trend data. Statistical reliability for trend data on all stream surveys will not be lower than the 80 percent confidence level at any time. Depending on drainage management plans and survey objectives, the following are several conditions which could influence remeasurements: evaluation of land management practices on aquatic habitat, stream improvement structures, virgin drainages, research methods, natural damages such as fires and floods, livestock grazing systems, and proposed or existing mining operations.

Records. All original reports, field records, maps and aerial photographs will be filed in the district manager's office in classi-file folders. Transect and other photographs will be mounted and captioned. Folders will be labeled "Keep in Current File Until Closed" in center of tab.

A complete duplicate of stream survey folders will be available to the appropriate regional office of the State Wildlife Agency on request.

One copy of completed Form 6671-5 - Stream Habitat Survey Summary and Analysis, will be forwarded to the BLM State Office.

Copies of Bureau and State correspondence related to stream survey management units should be exchanged between the district manager and state director to update files as new survey data become available.

PART II

Ocular Survey Procedure

This section suggests guidance and standards for conducting ocular stream habitat surveys on national resource land.

The ocular survey presents an alternative stream habitat survey procedure to the transect procedure. The ocular survey is a quick method (approximately 1 mile of stream/1.5 hours) for obtaining basic inventory data of a nonstatistical nature. Although the ocular survey data may be used alone, the transect survey procedure should include the ocular method as specified in this technical note under the Levels of Survey.

Office Procedure

Office procedures used under this method are similar to those used in the transect procedure referred to in Part I.

Field Procedure

Field habitat surveys shall be conducted during low water periods when there is no snow or ice cover.

The ocular survey incorporates all aspects of a Level III and II transect survey with the exception of the establishment and reading of transects and computation of limiting factors.

Locating Stations. Stations are located in the field by use of base maps and aerial photographs. Field locations are based on the predetermined location of milepost spots and/or changes in geomorphic and hydrologic conditions along the stream. Stations can be marked on the ground for reference. Stations can be marked by either a 4" x 4" aluminum tag, metal tag, or rock cairn or other suitable marker, and a note made on form stating type of marker used. A description for the identification and location of transects sites necessary for a Level I ocular survey are presented in Part I.

Locating Camera Points. Refer to corresponding section in Part I.

Coding of Pool Habitat. Appendix Exhibit 7 presents a guide for coding pool habitat. The code is qualitative and of relative value; i.e., do not compare streams that are divergent in size. The respective colors are traced on the stream and the numerical code attached to better describe pool habitat characteristics (Illustration 3). If stream has only warm water fisheries significance, the numerical code remains the same; however, the color code is black for pool habitat conditions.

Coding of Trout Spawning Habitat. Appendix Exhibit 8 presents a guide for color coding trout spawning habitat. The code is qualitative and of relative value; i.e., do not compare streams that are divergent in size.

The code is applied to each stream surveyed. Coding of other fish spawning habitat is to be covered under the Collecting Related Habitat Information section.

Other Factors. Appendix Exhibit 9 lists other aspects of the stream habitat which are to be coded to a base map.

Measurement of Habitat Factors. Refer to corresponding section in Part I. All habitat factors are accomplished under an ocular Level I objective. Some of the Habitat Factors described in Part I do not apply to an ocular Level III or II objective. The status of the factors are as follows:

A. Stream Width. Minimum effort for Level II ocular survey is an estimated width.

B. Riffle Width (not applicable).

C. Average Depth. Minimum effort for Level II ocular survey is an estimated average depth.

D. Pool. Pool class rating as described in Part I is utilized; however, for Level II ocular survey, utilize the procedure described in Part II under coding of pool habitat.

E. Stream Bottom Materials. Utilize description in Part I when applying the Level II ocular objective. However, amount of bottom materials are estimates and entered on Form 6671-2.

F. Bank Cover (optional). Stream channel stability form (Appendix Exhibit 3) utilizes vegetation density as a measurement. Vegetative type can be placed on Form 6671-2 (Appendix Exhibit 2).

G. Bank Stability (optional). Stream channel stability form (Appendix Exhibit 3) - as used to rate stability.

H. Ungulate Damage. Estimate the percent of streambank damage caused by ungulate use and record on Form 6671-2. The ungulate class (see Part I) should be recorded in the remarks section of Form 6671-2.

I. Aquatic Flora. (Not applicable).

J. Measurement of Stream Gradient. Refer to corresponding section in Part I.

K. Velocity and Discharges. Refer to corresponding section in Part I.

L. Temperature. Refer to corresponding section in Part I.

M. Turbidity. Refer to corresponding section in Part I.

N. Spawning Gravels. Actual measurement of spawning gravels is optional; however, a qualitative evaluation is necessary (see Appendix Exhibit 8).

O. Access. Refer to corresponding section in Part I.

P. Sinuosity. An estimation of sinuosity is usually adequate.

Q. Stream Stage. Stream stage is important in that accuracy of doing surveys lessens when stream is in or near flood stage. See Illustration 6 for explanation of various stages.

R. Migration Blocks. The presence or absence of blocks often determines fish species composition in a mountain stream. Explanation of migration block ratings are found in Appendix Exhibit 9.

Collecting Related Habitat Information

A. Channel Obstructions. Refer to corresponding section in Part I.

B. Channel Debris. Refer to corresponding section in Part I.

C. Pollution. Refer to corresponding section in Part I.

D. Channel Changes. Refer to corresponding section in Part I.

E. Potential and Active Erosion Sources. Refer to corresponding section in Part I.

F. Loss of Stream Flow. Often stretches of stream channels go dry during low water periods; however, the stream above the intermittent stretch often maintains sufficient water volume to support a fishery. Since fish may pass through the intermittent stretch during flow periods, the stretch is considered to have fisheries value and is coded brown on the base map (Appendix Exhibit 9).

G. Beaver Information. Refer to corresponding section in Part I.

H. Fish Planting Access Sites. Refer to corresponding section in Part I.

I. Angler Use. Refer to corresponding section in Part I.

J. Fish. Refer to corresponding section in Part I.

K. Impoundment Sites. Refer to corresponding section in Part I.

L. Spring Sources. Refer to corresponding section in Part I.

M. Fish Stocking. Refer to corresponding section in Part I.

N. Streambank and Channel Stability Characteristics. It is desirable that streambank and channel stability characteristics be rated. The USFS has developed a procedure to determine the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information concerning the ability of a stream to adjust and recover from potential changes in flow and/or increases in sediment load (Appendix Exhibit 3).

The information should be gathered for the full length of a stream to determine critical stretches sensitive to increased water flows and/or grazing. Also, the information may be gathered at a "point" for projects, such as bridge sites, campgrounds, water gaps, trail crossings, etc.

For a detailed explanation of Exhibit 3, refer to the publication "Hydrologic Effects of Vegetation Manipulation, Part II" by USDA Forest Service, Northern Region, Missoula, Montana.

O. Nonfishery Habitat. Many stream channels are ephemeral, lack sufficient water volume, or at too high an elevation to support fisheries. These channels are coded green (Appendix Exhibit 9).

P. Other Factors. Campgrounds, fence obstructions to recreation use, unauthorized trespass, etc., should be noted and the effect on the fishing habitat described.

Recording Field Data. The Stream Reach Inventory and Channel Stability Evaluation Forms (6671-2 and 6671-3) are designed for the recording of habitat information collected and/or measured. Often separate forms are filled for a given stream. A separate form is required when a change occurs in hydrologic character of the stream. Examples of changes in hydrologic character are sometimes quite subtle. Following is a list of habitat changes occurring either alone or in different combinations that may require the filling out of a separate form.

1. Obvious change in sinuosity.

2. Obvious change in stream gradient and/or velocity.

3. Obvious change in pool-riffle ratio.

4. Change in percent of ungulate damage of 10 percent or more.

5. Change in resident habitat rating.

6. Change in spawning habitat rating.

7. Change in rating of any one of the indicators listed on the Stream Channel Stability Field.

   Evaluation Form (Appendix Exhibit 3).

It is sometimes difficult to determine if the change in channel habitat covers sufficient length to merit the filling out of an additional form. When such a situation arises, it is better to inventory the channel at the greater frequency. It will not be unusual to rate stream stretches less than a quarter mile in length. Usually each length rated will exceed several miles on rivers and become progressively smaller with smaller stream sizes.

Instructions for completing items on Form 6671-2 (Appendix-Exhibit 2) as follows:

1. Survey level - enter either III, II, or I, which represents the level of the survey.

2. Survey date - self-explanatory.

3. Observer(s) - self-explanatory.

4. State - self-explanatory.

5. County - self-explanatory.

6. District - self-explanatory.

7. Resource Area - self-explanatory.

8. Survey unit - enter name of the stream. When the survey unit is an unnamed tributary, the parent stream should be noted in parenthesis.

9. Drainage unit - enter the name of the water course the stream unit flows into. If the drainage unit is unnamed, enter the name of the water course the drainage unit flows into and note in parenthesis.

10. Reach identification - enter station numbers or other identification from field map.

11. Survey unit drainage size - enter in acres.

12. Reach length - enter miles to nearest .05.

13. Planning unit - enter name of URA planning unit.

14. Access - enter type of closest access to survey unit and state approximate distance from survey unit.

15. State water quality class - self-explanatory.

16. State fishing water class - self-explanatory.

17. State stream catalog number - self-explanatory.

18. Multiple use zone - enter the multiple use zone for each station, i.e., people, travel, water, grazing, etc.

19. Threatened or endangered species - enter common name of animal species.

20. Type of fishing - enter coldwater, warmwater, anadromous, adfluvial, etc.

21. Sinuosity - enter ratio of stream length to a straight line.

22. Gradient - enter stream gradient to nearest .1 percent.

23. Stream order - enter stream order.

24. Stream stage - enter stream stage, explanation on Illustration 6.

25. Turbidity - enter clear, milky, or muddy.

26. Stream size - use an asterisk behind all estimated measurements for width, depth, velocity, and discharge.

    a. Width - enter width of water column to nearest foot for survey date; enter width of channel for normal high water line.

    b. Average depth - enter average water depth to nearest inch for survey date; enter acreage water depth for normal high water line. Procedure for taking average depth is explained in <u>Measurement of Habitat Factors</u>, Item C in Part I.

    c. Velocity - enter water velocity to nearest .1 foot per second.

    d. Discharge - note whether discharge is estimated or measured (float = F, velocity headrod = VHR, or metered = M).

27. Pool-riffle ratio - enter percent of stream in pool and riffle.

28. Percent ungulate damage - enter estimated percent of the streambank detrimently affected by grazing. Most serious damage is caused by sloughing of streambanks by trampling and/or removal of perennial streambank vegetation by grazing.

29. Riparian width - enter average width of riparian zone for each bank. Riparian habitat is that vegetation which is existent because of the easy availability of water. Enter symbol from Illustration 10 for vegetative type.

30. Temperature - self-explanatory.

31. Sky condition - enter clear, partly cloudy, or cloudy.

32. Pool habitat rating - enter numerical code from Exhibit 7 which best describes the habitat.

33. Spawning habitat rating - enter rating from Exhibit 8 which best describes the habitat.

34. Soils description - use Appendix-Exhibit 10 for classes; estimate percentages of the various bank components.

35. Landform...Geologic type - enter code from Illustration 9.

36. Stability classification (USFS) - enter numerical score derived from evaluating channel and bank stability (Appendix-Exhibit 3). Stream channel stability field evaluation field training is necessary for anyone not familiar with the procedure developed by the Northern Region of the U.S. Forest Service.

37. Size..bottom material - enter to nearest percent; total to equal 100 percent.

38. Upstream migration block - enter number and kinds of respective blocks.

39. Other remarks - enter significant information not provided for in items 1 through 38 or under the related habitat factors section.

<u>Water Quality Habitat Survey</u>. Refer to corresponding section in <u>Part I</u>.

<u>Biological Surveys</u>. Refer to corresponding section in <u>Part I</u>.

Analysis of Data

In contrast to the transect survey procedure, the ocular survey procedure does not utilize the computation of limiting factors to aid the fisheries biologist in analysis of data. The data are analyzed for a given drainage for any of a number of possible objectives. Analysis is to be accomplished by a fisheries biologist and presented in a manner acceptable for developing resource management alternatives. The manner of presentation is left to the imagination of the fisheries biologist and to the format for which it is being developed. It is beneficial if the surveyor completes as much of the analysis as he is capable.

Reporting and Storing Data

Refer to corresponding section in <u>Part I</u>.

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Appendix I Exhibit 1
Form 6671-1

STREAM HABITAT SURVEY FIELD FORM

1. State	3. District	5. Drainage	7. Location: T. R. Sect.	9. Investigators
2. County	4. Resource Area - P.U.	6. Stream	8. Survey Station	10. Date

		Water Surface										Stream Bottom											Stream Bank														
				Depths				Pools															Left Bank						Right Bank								
Transect Number	Total Width Of Channel	Water Width	Riffle Width	1	2	3	Avg.	Width	Class	Location	Feature	Aquatic plants	Bedrock	Boulders + 12"	Large Rubble 6 - 12"	Small Rubble 3 - 6"	Coarse Gravel 1 - 3"	Fine Gravel 0.1 - 1.0"	Sand	Silt	Clay	Muck	Organic Debris	Cover	Stability	Class	Landform Gradient	Ungulate Damage	Riparian Zone	Cover	Stability	Class	Landform Gradient	Ungulate Damage	Riparian Zone	Stream Gradient	Velocity
11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.

49. Access______________ 50. Water Temperature______________ 51. Air Temperature____________ 52. Time______________

53. Elevation______________ 54. Turbidity______________ 55. Water Analysis: Hach Kit____Chemical_____Coli______

56. Water Quality Class (State)______________ 57. DWR (State) Fishing Water Class______________ 58. DWR (State) Stream Catalog No.____________ Section No.____________ 59. MU Zone__________

60. Land Type______________ 61. Vegetative Type______________ 62. Discharge (c.f.s.)________ 63. % Stream Shaded_______

Exhibit 1. Stream Habitat Survey Field Form for Transect Procedure

Appendix I Exhibit 2
Form 6671-2

1. Survey Level___ 2. Survey Date____ 3. Observer(s)__________________ 4. State___________

5. County__________ 6. District_______ 7. Resource Area_________ 8. Survey Unit___________

9. Drainage Unit_________ 10. Reach Ident.________________ 11. Survey Unit Drainage Size (Ac.)__________

12. Reach Length Miles: NRL ___ Other Fed.___ State___ Private___ 13. Planning Unit_______ 14. Access____ 15. State Water Qual. Class_________

16. State Fisheries Water Class________ 17. State Stream Catalog No.______________

18. Multiple Use Zone_______ 19. Threatened or End. Wildlife________ 20. Type of Fishery__________ 21. Sinuosity*___

22. Gradient*_______ 23. Stream Order____ 24. Stream Stage______ 25. Turbidity*___________

26. Stream Size on Survey Date* Width___ Av. Depth___ Velocity___ Discharge___
Stream Size Normal High Water* Width___ Av. Depth___ Velocity___ Discharge___

27. Pool-Riffle* Ratio______ 28. %Ungulate* Damage______ 29. Riparian Width: Rt. Bank__________ Lf. Bank__________ Veg.Type__________

30. Temp: Water____ Air____ Time____ 31. Sky Cond._______ 32. Pool Habitat* Rating______ 33. Spawning Hab* Rating____

34. Bank Soil Description_______ 35. Land Form and/or Geologic Type________ 36. Stability Classification_______

37. Size Composition of Bottom Material. Use Percent (Total 100%)*

Sand, Silt, Clay, Muck ___
Fine Gravel 0.1-1 inch ___
Coarse Gravel 1-3 inch ___
Small Rubble 3-6 inch ___
Large Rubble, 6-12 inch_____
Small Boulder 1-3 feet_____
Large Boulder 3+ feet_____
Exposed Bedrock _____

38. Upstream Migration Block: Complete ____ High Water ____ Low Water ____

39. Other Remarks________________________________
____
____

Instructions: Use separate rating forms (6671-2 & 6671-3) for each length of stream that appears to change in character (see Part II, Recording Field Data). Complete the inventory items using maps, aerial photos, and field observations and measurements.

*Place an asterisk for estimated measurements.

Exhibit 2.—Stream Habitat Survey Form for Ocular Survey.

Exhibit 3. -- Stream Channel Stability Field Evaluation Form.

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
UPPER BANKS								
Landform Slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%	4	Bank slope gradient 40-60%	6	Bank slope gradient 60%+	8
Mass Wasting Existing or Potential	No evidence of past or potential for future mass wasting into channels.	3	Infrequent and/or very small. Mostly healed over. Low future potential.	6	Moderate frequency & size, with some raw spots eroded by water during high flows.	9	Frequent or large, causing sediment nearly yearlong or imminent danger of same.	12
Debris Jam Potential Floatable Objects	Essentially absent from immediate channel area.	2	Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.	6	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	6	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	9	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio<7.	1	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	3	Inadequate. Overbank flows common. W/D ratio 25.	4
Bank Rock Content	65%+ with large, angular boulders 12"+ numerous	2	40-65%, mostly small boulders to cobble 6-12".	4	20-40%, with most in the 3-6"diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	4	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	4	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	8	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	4	Some new increases in bar formation, mostly from coarse gravels.	8	Moderate deposition of new gravel & coarse sand on old and some new bars.	12	Extensive deposits of predominately fine particles. Accelerated bar development.	16
BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	1	Rounded corners & edges, surfaces smooth & flat	2	Corners & edges well rounded in two dimensions.	3	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	1	Mostly dull but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, ± 15%; i.e., 35-65%.	3	Predominately bright, 65%+ exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	2	Moderately packed with some overlapping.	4	Mostly a loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution Percent Stable Material	No change in sizes evident. Stable materials 80-100%	4	Distribution shift slight. Stable materials 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.	12	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	6	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation Moss & Algae	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	1	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	2	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS								

Record the values in each column for a total reach score. (E.___+ G.___+ F.___+ P.___ = ___)

Reach score of: 38 = Excellent, 39-76 = Good, 77-114 = Fair, 115+ = Poor.

Circle only one of the numbers in parenthesis for each indicator rated. If condition falls between the conditions described, cross out the given number and write in the intermediate value. The above Form is to be completed each time Form 6671-2 is completed (see Part II, Recording Field Data). The above Form was developed by Hydrologists in the Northern Region of the United States Forest Service.

STREAM HABITAT
TRANSECT PHOTO IDENTIFICATION

DATE

SAMPLE STATION NO.

TRANSECT NO.

NAME OF SURVEY UNIT

DISTRICT

PLANNING UNIT

Exhibit 4. - Photo Survey Form.

(OVER)

Instructions

1. Fold upper black corner under when photographing down - stream view.

2. Fold lower black corner under when photographing up-stream view.

3. Fold both black corners under when photographing cross-channel view.

Exhibit 4. - Stream Habitat Transect Photo Identification.

STREAM HABITAT SURVEY SUMMARY AND ANALYSIS

1. State -- County	2. District	3. Resource Area -- P.U.
4. Drainage	5. Stream Unit	6. Location T. R. Sect.
7. Investigators 7.		8. Date

General Data

9. Total length of stream (mi.)

10. Total length of stream:

	Surveyed (mi.)	Percent Ownership
a. BLM	____	____
b. USFS	____	____
c. Public, other	____	____
d. Private	____	____

11. Total No. sample stations:
 a. BLM ____
 b. Public ____
 c. Private ____

12. Total of all stream width measurements (ft.) ____

13. Total channel width (ft.) ____

14. Total width - all pools (ft.) ____

15. Total width of all pools classed 1, 2, and 3 (ft.) ____

16. Total footage of desirable bottom materials (ft.) ____

17. Total spawning gravels (ft.) ____

18. Sum of cover ratings ____

19. Sum of stability ratings ____

20. Elevation: (M.S.L.)
 a. Lowest ____
 b. Highest ____

21. Multiple use zones ____
22. Number of camera points ____
23. Total cost
 a. Planning ____
 b. Salaries ____
 c. Equipment ____
 d. Analysis of data ____

24. Cost per station ____

Priority "A" Limiting Factors

25. Percent of total stream width in pools ____

26. Pool-riffle ratio, % optimum ____

27. Pool quality, & optimum ____

28. Percent of stream bottom with desirable materials ____

29. Bank cover, % optimum ____

30. Bank stability, % optimum ____

31. Percent of habitat optimum ____

Priority "B" Limiting Factors

32. Average depth of stream (ft.) ____

33. Average width of stream (ft.) ____
 Percent stream shaded ____

34. Percent of bottom with clinging vegetation (ft.) ____
 Percent sedimentation ____

35. Percent of bottom with rooted vegetation (ft.) ____

36. Average stream gradient (%) ____
 Percent landform gradient RB ____
 LB ____

37. Average stream velocity (f/s) ____

38. Stream discharge (c.f.s.) ____

39. Average water temperature: (°F or °C) Max. ____
 Min. ____

40. Turbidity description ____

41. Access: (mi.)
 a. Remote ____
 b. Low standard trails ____
 c. Improved trails ____
 d. Low standard roads ____
 e. Improved roads ____

42. Water quality analysis:
 a. Hatch kit ____
 b. Chemical ____
50. c. Coli ____

Exhibit 5. - Stream Habitat Survey Summary and Analysis.

43. General Remarks

44. Narrative Report - Watershed Condition

45. Management Recommendations

Exhibit 5.—Stream Habitat Survey Summary and Analysis.

STREAM HABITAT SURVEYS REFERENCE FORM

MEASUREMENT OF STREAM WIDTH AND DEPTH

1. Measure stream width to nearest foot. When a transect bisects separated channels, list each channel separately from left to right looking downstream, in alphabetical order, i.e., T1a, T1b, etc.

2. Measure depth at 1/4, 1/2, and 3/4 width to nearest inch. Sum of measurements ÷ 4 = avg. depth.

BANK COVER MEASUREMENTS (50 feet above and below transect)

4 - Medium to heavy cover of trees and/or tall shrubs
3 - Scattered trees and/or dense tall shrubs
2 - Medium to heavy cover of tall grass, forbs and/or low shrubs
1 - Scattered low grass, forbs and/or small shrubs or exposed bank.

(Vegetation must be within 1/2 its height of water's edge to qualify as streambank cover.)

BANK STABILITY

4 - Bank totally stable
3 - >50% stable
2 - <50% stable
1 - Totally unstable

BANK COVER - Dominant composition of streambank components 50 feet above and below the end of transect. Composition classes can be boulder, gravel bar, exposed soil, grass and rocks, grass and soil, soil and rocks, rooted soil (trees and brush), etc.

POOL FREQUENCY AND LOCATION

Each intersected pool width is measured to nearest foot. Designate location by symbol L (left), R (right), and C (center) in reference to left-hand bank facing downstream.

POOL CLASS RATINGS

Size (Measurements refer to the longest axis of the intersected pool.)
3 - Pool larger or wider than average width of stream.
2 - Pool as wide or long as average stream width.
1 - Pool much shorter and narrower than average stream width.

Depth Ratings	Total Ratings	Pool Class	UNGULATE DAMAGE
3 - over 3 feet	8-9	1	4 - Bank stable; 90-100% impact free.
2 - 2-3 feet	7	2	3 - < 50% damage; 50-90% impact free.
1 - under 2 feet	*5-6	3	2 - > 50% damage; 50-90% damage.
	4-5	4	1 - Excessive; 90-100% damage.
	3	5	

Cover Ratings
3 - Abundant cover
2 - Partial cover
1 - Exposed

*Sum of 5 must include 2 for depth and 2 for cover.

CLASSIFICATION OF BOTTOM MATERIAL

Fine Gravel	0.1 - 1.0 inches
Coarse Gravel	1 - 3 inches
Small Rubble	3 - 6 inches
Large Rubble	6 - 12 inches

(See field form for others)

(measure total intercepted bottom materials to nearest foot. Aspect, not individual materials, should govern classification.)

MEASUREMENT OF WATER TURBIDITY

Clear)
Milky) Account for source
Muddy)

FISHERMAN ACCESS

Remote - No trail
Low-standard trail - Game or nonmaintained trail
Improved trail - Maintained
Low-standard roads - Without drainage
Improved roads - With drainage

AQUATIC VEGETATION

R - rooted - (record to nearest foot of intercepted vegetation)
C - clinging

TICKLER LIST FOR REMARKS

1. Dams and barriers
2. Pollution information
3. Channel changes (manmade)
4. Erosion potential
5. Fish (number--size--species)
6. Creel information and fishing pressure
7. Number fish planting access sites
8. Spring sources
9. Water diversions
10. Beaver activity
11. Spawning gravel availability
12. Camera point information
13. Channel debris
14. Loss of streamflow

Exhibit 6. - Stream Habitat Surveys Reference Form.

Good - Solid Blue Line

G-1 One or more class one pools per half mile with at least 35% of stream area in class one, two and/or three pools, and to include at least two classes of above pools, but not to exceed 65-70% of total area.
G-2 One or more class one pools per half mile with at least 35% of stream in class one pools, and total area class one pools not to exceed 65-70%.

Fair - Blue Slashes and Dashes

F-1 Class one, two and/or three pools exceed 70% of total stream area per half mile.
F-2 Stream area consists of 20-35% of class one pools; no class two or three pools per half mile.
F-3 Class two and three pools comprising 35% or more of stream area; no class one pools per half mile.
F-4 Stream area consists of 20-35% of class one, two and/or three pools with at least two of the above pool classes represented per half mile, including at least one class one pool.

Poor - Blue Dots (at least 4 dots per mile)

P-1 Stream area consists of a combination of class one, two and/or three pools with at least two pool classes represented and total area of above pools not to exceed 10-20% per half mile.
P-2 Two or more class two pools present per half mile, not to exceed 10-20% of stream area; no class one or three pools.
P-3 Two or more class three pools per half mile, to include 20% or more of stream area; no class one or two pools.
P-4 One or more class one pools per half mile, not to exceed 10-20% of stream area; no class two or three pools.

Virtually None - Blue Dots (two dots per mile)

V-1 Class three pools comprise less than 20% of stream area per half mile; no class one or two pools.
V-2 Less than 10% of stream per half mile in class two pool; no class one or three pools.
V-3 Class three and class two pools comprise less than 10% of stream area per half mile; no class one pools.

None - Blue lines, slashes, and dots absent

N-1 No class one, two, and three pools per quarter mile stretch.

Exhibit 7.—Criteria for Classifying Pool Habitat (Trout) with Color Code for Placing on Base Map.

Good - Solid Orange Line ___________

Fair - Orange Slashes and Dashes // ___ // ___

Poor - Orange Dots (at least 4 dots per mile). . . .

Virtually none - Orange Dots (two dots per mile) . .

None - Orange lines, slashes, or dots absent

Spawning habitat is based on needs of trout. Large trout can handle larger materials, but the rating is based on materials from .25 up to 2 inches in diameter normally used by trout less than 16 inches total length. Good to excellent spawning habitat means a good pool riffle ration (near 50:50) and a preponderance of spawning gravel. Fair spawning habitat is based on a number of factors: pool riffle ratio could be 50:50, but size of spawning material is borderline; pool riffle is 80-20 and size of spawning material is good, etc. Poor spawning habitat means the spawning sites are scattered either because of too much pool or largeness of materials. Virtually none means an occassional site (one or two per mile).

Exhibit 8. — Criteria for Classifying Trout Spawning Habitat with Color Code for Placing on Base Map.

A red line means habitat is suitable for fish; however, fish cannot move upstream because of steepness. Usually a lake or pool habitat above steep section has or can have fish that drift downstream. When a red line occurs, pool and spawning codes are also placed on the map.

A brown line indicates fish use is possible during high water but no spawning or resident habitat is available year around.

A green line indicates that the stretch has no direct fisheries significance. No fisheries significance does not preclude the importance of water quality, sediment transport, cooling effect, etc. to main streams.

Polluted streams are denoted by a pink line; there must be no fish in a polluted section. A • • • • pink line indicates that the stretch is harmed but not dead from chemical or sewage pollution.

A black color is used to denote non-trout habitat. The criteria as listed on Exhibit 7 is utilized for placement on the base map.

C=Culvert
F=Falls
CA=Cascade
DB=Debris Block
B=Bridge

A red color means a complete upstream migration barrier; blue means a high water upstream migration barrier; green means a low water upstream migration barrier; orange means no barrier.

ç=Beaver Pond - A red color means an active pond; green means an inactive pond.

SED=Sediment Source - Magnitude of sediment sources is a subjective rating. A large sediment source to a small stream may be significant, but the same size source on a large stream may not be significant. If the sediment source appears to be causing accelerated damage, it should be rated. The accumulative effect of "insignificant" sediment sources should not be overlooked.

Exhibit 9.—Criteria and Color Code for Classifying and Placing on Base Map Other Aspects of Stream Stretches Not Listed in Exhibits 7 and 8.

Texture	Approximate Size
Clay	0.074 mm 75-95%
Loam	0.074 mm 60-75%
Silt	0.074 mm 90-100%
Sand	0.074-2.5 mm 55-100%
Fine Gravel	2.5-25 mm (0.1-1 inch)
Coarse Gravel	25-76 mm (1-3 inches)
Small Rubble	76-152mm (3-6 inches)
Large Rubble	152-305 mm (6-12 inches)
Boulder	305 mm (12 inches or larger)
Bedrock	

The above texture list is not complete. Combinations such as silty clay, silty clay loam, loamy very fine sand, etc. exist and are classified under the USDA textural class system.

Exhibit 10.—Bank Material Composition.

DISCHARGE MEASUREMENT RECORD
Velocity - Head Rod Method
Forest Service - Pacific Northwest Region

Forest ______________
W/S No. ______________
Compiled By ______________
Checked By ______________

District ______________ Drainage ______________ Station No. ______________
Turpidity (ppm) ______________ Date ______________ Discharge ______________ cfs
Party ______________ Gage Height * ______________ Air ______ °F@ ____ Water ______ °F@ ____
Peak Gage Height ______________ Date of Occurence ______________

(1) Distance From Initial Point	(2) Width	(3) Depth: Stream	(4) Depth: Hydraulic Jump	(5) Velocity: h	(6) Velocity: v	(7) Area	(8) Discharge	(9) Constants**: h	(10) Constants**: v
								.01	.60
								.02	1.13
								.03	1.39
								.04	1.60
								.05	[illegible].79
								.06	1.96
								.07	2.12
								.08	2.[illegible]
								.09	2.[illegible]
								.10	2.54
								.11	2.6[illegible]
								.12	2.78
								.13	2.89
								.14	3.00
								.15	3.[illegible]
								.16	3.2[illegible]
								.17	3.[illegible]
								.18	3.40
								.19	3.50
								.20	3.59
								.25	4.01
								.30	4.39
								.35	4.74
								.40	5.07
								.45	5.38
								.50	5.67
								.55	5.95
								.60	6.2[illegible]
								.65	6.47
								.70	6.71
								.75	6.95
								.80	7.1[illegible]
								.85	[illegible].39
								.90	7.61
								.95	7.82
								1.00	8.02
								1.10	8.[illegible]
								1.20	8.[illegible]9

Exhibit 11. - Example of a Velocity Headrod Discharge Measurement Form.

(9) Constants h	(10) ** v
1.30	9.14
1.40	9.49
1.50	9.82
1.60	10.14
1.70	10.46
1.80	10.76
1.90	11.05
2.00	11.34
2.20	11.90
2.50	12.68

** $v = 8.02\sqrt{h}$ Where 'h' is the velocity head and 'v' is velocity in ft. per sec.

* Gage Height - Measurement after gage is tripped (present water level).

EXAMPLES OF COMPUTATIONS

$$\text{width} = \frac{\text{3rd reading minus beginning from Column (1)}}{2}$$

$$\text{or width} = \frac{\text{4th reading minus 2nd reading}}{2}$$

stream depth = head rod reading narrow edge

stream jump = head rod reading wide edge

'h' = jump - stream depth

'v' = from "constant" table

area = width x stream depth, of Column (2) x (3)

discharge = velocity x area, or Column (6) x (7)

Take minimum of 10 readings or approximately at 1½ to 2-foot intervals across stream along same line each time.

Gage Height - Measurement after gage is tripped (present water level).

Peak Height - Measurement before gage is tripped. (Height water has reached since last measurement).

Exhibit 11. - Example of a Velocity Headrod Discharge Measurement Form.

9-275G
(Mar. 1972)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Meas. No. ....
Comp. by ....
Checked by ....

DISCHARGE MEASUREMENT NOTES

Sta. No. ....

....

Date ...., 19...... Party ....

Width .... Area .... Vel. .... G. H. .... Disch. ....

Method .... No. secs. .... G. H. change .... in .... hrs. Susp. ....

Method coef. .... Hor. angle coef. .... Susp. coef. .... Meter No. ....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter ....

Date rated .... for rod, other.

Meter .... ft. above bottom of weight.

Spin before meas. .... after ....

Meas. plots .... % diff. from rating ....

Wading, cable, ice, boat, upstr., downstr., side

bridge .... feet, mile, above, below

gage, and ....

Check-bar, found ....

changed to .... at ....

Correct ....

Levels obtained ....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section ....

Flow .... Weather ....

Other .... Air ....°F@ ....

Gage .... Water ....°F@ ....

.... Record removed .... Intake flushed U/L ....

Observer ....

....

Control ....

....

Remarks ....

....

....

G. H. of zero flow .... ft.

GPO:1972—O-461-858

Exhibit 12. - Example of U.S. Geological Survey Discharge Measurement Form.

.0 .10 .20 .30 .40 .50 .60 .70 .75

River at—

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY		Adjusted for hor. angle or ---------	Area	Discharge
							At point	Mean in vertical			
⊙											

.80 .85 .90 .92 .94 .96 .97 .98 .99 1.00 .99 .98 .97 .96 .94 .92 .90 .85 .80

.0 .10 .20 .30 .40 .50 .60 .70 .75

Exhibit 12. - Example of U.S. Geological Survey Discharge Measurement Form.

1. Species Diversity or Dominance*

   a. Actual number of species present

   b. Number of species present divided by number of individual organisms.

$$\text{Diversity Index} = \frac{\#\text{species}}{\#\text{organisms}}$$

   c. SCI - Sequential Comparison Index

$$\text{SCI} = \frac{\text{number of runs}}{\text{number of specimens}}$$

   This indice is suited best for monitoring of short term impacts, such as from silts and sediments.

   Ref: Cairns, J. Jr., and K.L. Dickson. 1971. A Simple Method for the Biological Assessment of the Effects of Most Discharges on Aquatic Bottom Dwelling Organisms. Journal W.P.C.F. 43:755-772.

   d. Fisher Diversity Index explains the relationship between the number of species and the logarithm of the area studied. Best suited for organic pollution stresses.

$$\text{diversity } (d) = \frac{s - 1}{\log_n N}$$, where "s" is

   number of species and $\log_n N$ is the natural logarithm of the number of individuals.

   Ref: Wihlm, Jerry L. 1967. Comparison of Some Diversity Indices Applied to Populations of Benthic Macroinvertebrates in a Stream Receiving Organic Wastes. Journal W.P.C.F. 39(10) 1673-1683.

   e. Shannon-Weaver Diversity Index is suited for monitoring organic pollution, toxic substances, or continual static stress in the ecosystem.

$$\text{Species dominance diversity } (\bar{d}) = \overset{s}{\underset{1-i}{}} (Ni/N) \log_2 (Ni/N),$$

   Explanation of this formula can be found in the reference: Wilhm, J.L. & T.C. Dorris. 1968. Biological Parameters for Water Qaulity Criteria. Bioscience 18:477-481.

*d values less than 2.0 indicate a degree of stress due to pollutants; values greater than 3.0 indicate clean streams. For optimum characterization of the ecosystem it is recommended that these formulas not be used alone, but in conjunction with comparisons to species numbers, species listings, & biomass.

Exhibit 13. --Formulas for determing biological indices of water quality.

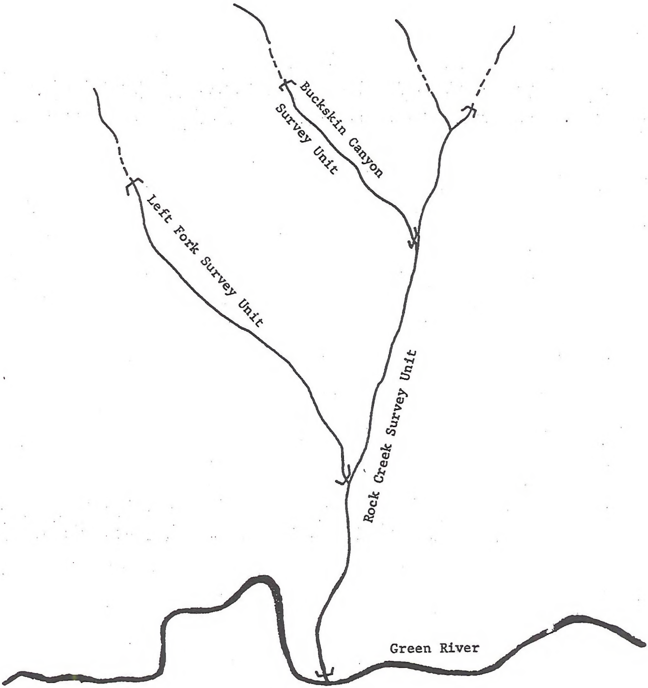


Illustration 1.--Diagram of stream survey unit designations (Survey units are shown between the symbols).

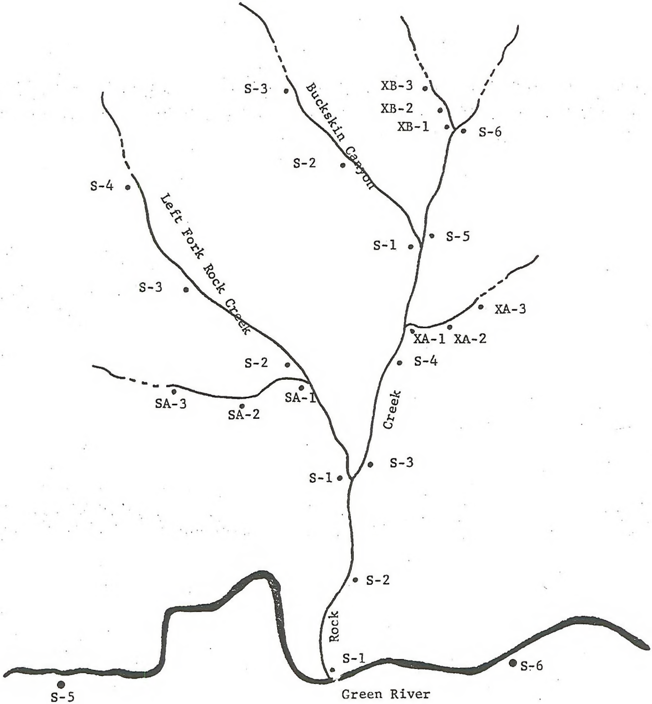


Illustration 2. Example of sample station numbering on a river-creek complex.

Appendix II Illustration 3

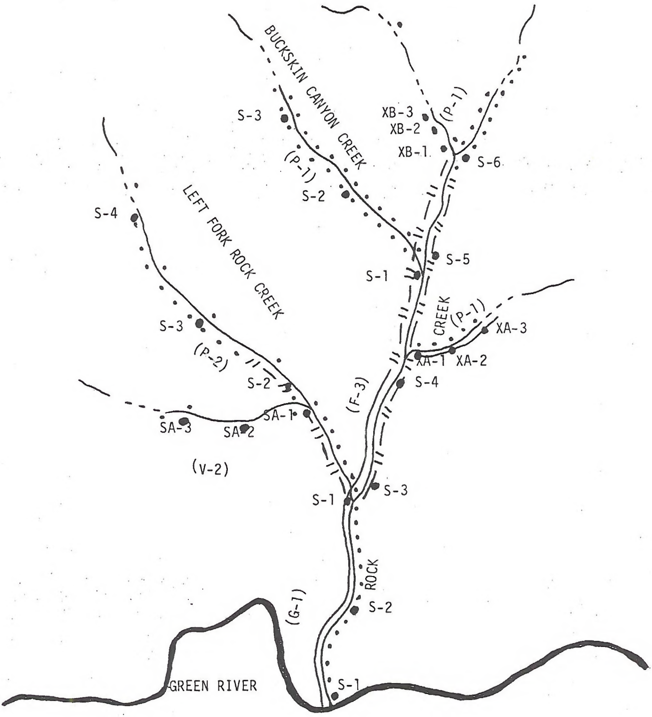


Illustration 3.—Example of sample station numbering and habitat coding on a river-creek complex. Facing downstream, pool habitat is placed on right side and spawning habitat is placed on left side.

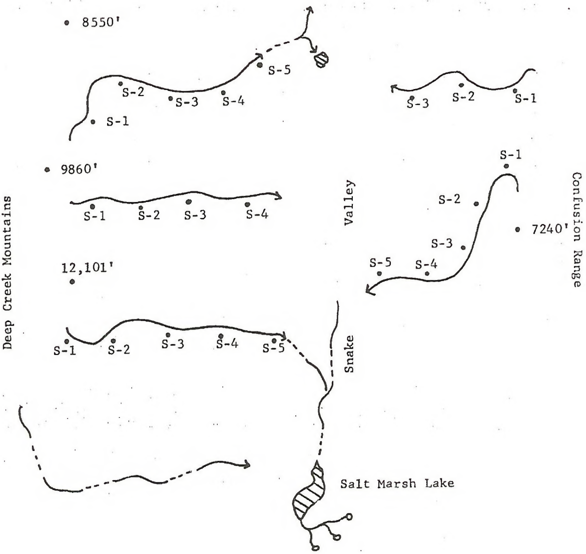


Illustration 4.- Diagram of stream survey station numbering in desert areas

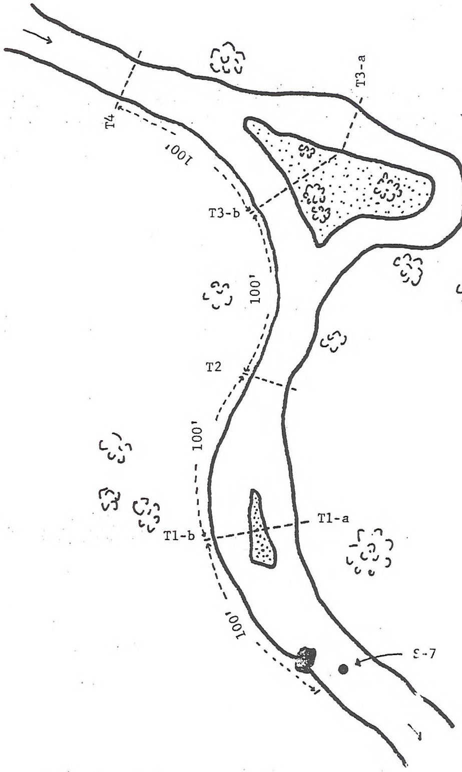
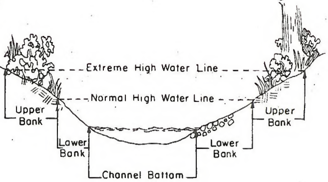
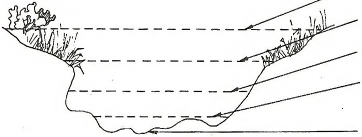


Illustration 5--Example of transect spacings

<u>Upper Bank</u> - That portion of the topographic cross section from the break in the general slope of the surrounding land to the normal high water line. Terrestrial plants and animals normally inhabit this area.
<u>Lower Banks</u> - The intermittently submerged portion of the channel cross section from the normal high water line to the water's edge during the summer low flow period.
<u>Channel Bottom</u> - The submerged portion of the channel cross section which is totally an aquatic environment.



These numbers, as shown below, relate to the surface water elevation relative to the normal high water line. A decimal division should be used to more precisely define conditions; i. e., 3.5 means 3/4ths of the channel banks are under water at the time of rating.



5 = Flooding. The flood plain is completely covered.
4 = High. Channel full to normal high water line.
3 = Moderate. Bottom and 1/2 of lower bank wetted.
2 = Low. Bottom covered but very little of the lower bank wet.
1 = "Dry". Essentially no flow. Water may stand in bottom depressions.

Illustration 6. Example of stream bank and stream bottom association (Top) and stream stage (Bottom).

Because of large areas of slack or slow waters on major rivers, the transect interval has been modified to assure adequate data collection in these areas of long continuous habitat types.

Because the width of major rivers is considerably over 50 feet, the 100 foot interval for transects is not appropriate. Therefore, a distance interval of 5 times the stream width has been found to be satisfactory in transect interval location. The following transect intervals are suggested for the maximum river widths shown:

Where the Stream Width @ Station is Between:		Factor		Transect Interval Distance
50 - 75 feet	=	5 x 75	=	375
76 - 100 feet	=	5 x 100	=	500
101 - 125 feet	=	5 x 125	=	625
126 - 150 feet	=	5 x 150	=	750
151 - 175 feet	=	5 x 175	=	875
176 - 200 feet	=	5 x 200	=	1000
201 - 225 feet	=	5 z 225	=	1125
226 - 250 feet	=	5 x 250	=	1250
251 - 275 feet	=	5 x 275	=	1375
276 - 300 feet	=	5 x 300	=	1500
301 - 325 feet	=	5 x 325	=	1625
326 - 350 feet	=	5 x 350	=	1750
351 - 400 feet	=	5 x 400	=	2000
401 - 450 feet	=	5 x 450	=	2250
451 - 500 feet	=	5 x 500	=	2500
501 - 600 feet	=	5 x 600	=	3000

Illustration 7.—Suggested Transect Intervals for Large River Habitat Survey.

Pool Class Rating Guide

Pool Class	Pool Length or Width	Pool Depth	Pool Shelter * (cover)
1	Greater than avg. stream width	2' - 3'	Abundant 1/
	Greater than ASW.	3' or deeper	Intermediate
	Greater than avg. stream width	3' or deeper	Exposed 2/
	Equal to ASW	3' or deeper	Abundant
2	Greater than avg. stream width	3' or deeper	Exposed
	Greater than ASW	2' - 3'	Intermediate
	Less than ASW	3' or deeper	Abundant
	Greater than avg.	< 2'	Abundant
	Equal to ASW	3' or deeper	Intermediate 3/
3	Greater than avg stream width	< 2'	Intermediate
	Equal to avg stream width	2' - 3'	Intermediate
	Equal to avg stream width	< 2'	Abundant
	Less than ASW	2' - 3'	Intermediate
4	Equal to avg stream width	Shallow 4/ < 2'	Exposed
	Less than avg stream width	Shallow < 2'	Abundant
	Less than avg stream width	< 2'	Intermediate
	Greater than ASW	< 2'	Exposed
5	Less than avg stream width	Shallow < 2'	Exposed

* Shelter = Logs, stumps, boulders in or overhanging pool. Dense beds of aquatic vegetation or overhanging banks.

1/ Abundant = More than 1/2 perimeter of pool has cover.
2/ Exposed = Exposed (little or no shelter or cover) less than 1/4 of pool perimeter has cover
3/ Intermediate = 1/4 to 1/2 perimeter of pool has cover.
4/ Shallow = Less than two feet in depth.

Illustration 8. - Pool Class Rating Guide.

Symbol	Tentative Name
1	Non-salty closed basins
2	Salt Playa basins
3	Riparian Alluvium (perennial flow)
4	Intermittent stream alluvium
5	Foothills (gentle sloping)
6	Low-lying mesas
7	High elevation mesa tops
8	Sedimentary uplands
9	Igneous rock uplands
10	Steep Rocky Slopes
11	Cliffs

Illustration 9.–List of Geomorphic Land Type Associations for Stream Habitat Surveys.

Symbol	Vegetative Type
1	Grassland
2W	Wet meadow or marsh
2D	Dry meadow or flood plain
3	Perennial Forbs
4	Sagebrush
5	Mountain Browse - shrub
6	Conifer
7T	Dense timber
7D	Down timber
7B	Brush
7R	Rocky
7I	Permanently inaccessible
7O	Other waste
8	Barren
9	Pinyon - Juniper
10	Broadleaf Riparian (aspen, alder, birch, maple, cottonwood, oak, willow, etc.)

Illustration 10.—List of Vegetative Types for Stream Habitat Surveys (re BLM-MR 4412.11A Ocular Reconnaissance Forage Survey Handbook).

TABLE OF POOL-RIFFLE PERCENT OPTIMUM

When total of all pools is this % of sample total feet	Percent - Pool Optimum Rating
50	100
49 or 51	98
48 or 52	96
47 or 53	94
46 or 54	92
45 or 55	90
44 or 56	88
43 or 57	86
42 or 58	84
41 or 59	82
40 or 60	80
39 or 61	78
38 or 62	76
37 or 63	74
36 or 64	72
35 or 65	70
34 or 66	68
33 or 67	66
32 or 68	64
31 or 69	62
30 or 70	60
29 or 71	58
28 or 72	56
27 or 73	54
26 or 74	52
25 or 75	50
24 or 76	48
23 or 77	46
22 or 78	44
21 or 79	42
20 or 80	40
19 or 81	38
18 or 82	36
17 or 83	34
16 or 84	32
15 or 85	30
14 or 86	28
13 or 87	26
12 or 88	24
11 or 89	22
10 or 90	20
9 or 91	18
8 or 92	16
7 or 93	14
6 or 94	12
5 or 95	10
4 or 96	8
3 or 97	6
2 or 98	4
1 or 99	2
0 or 100	0

Illustration 11. - Table of Pool-Riffle Percent Optimum for Use in Priority A Computations.